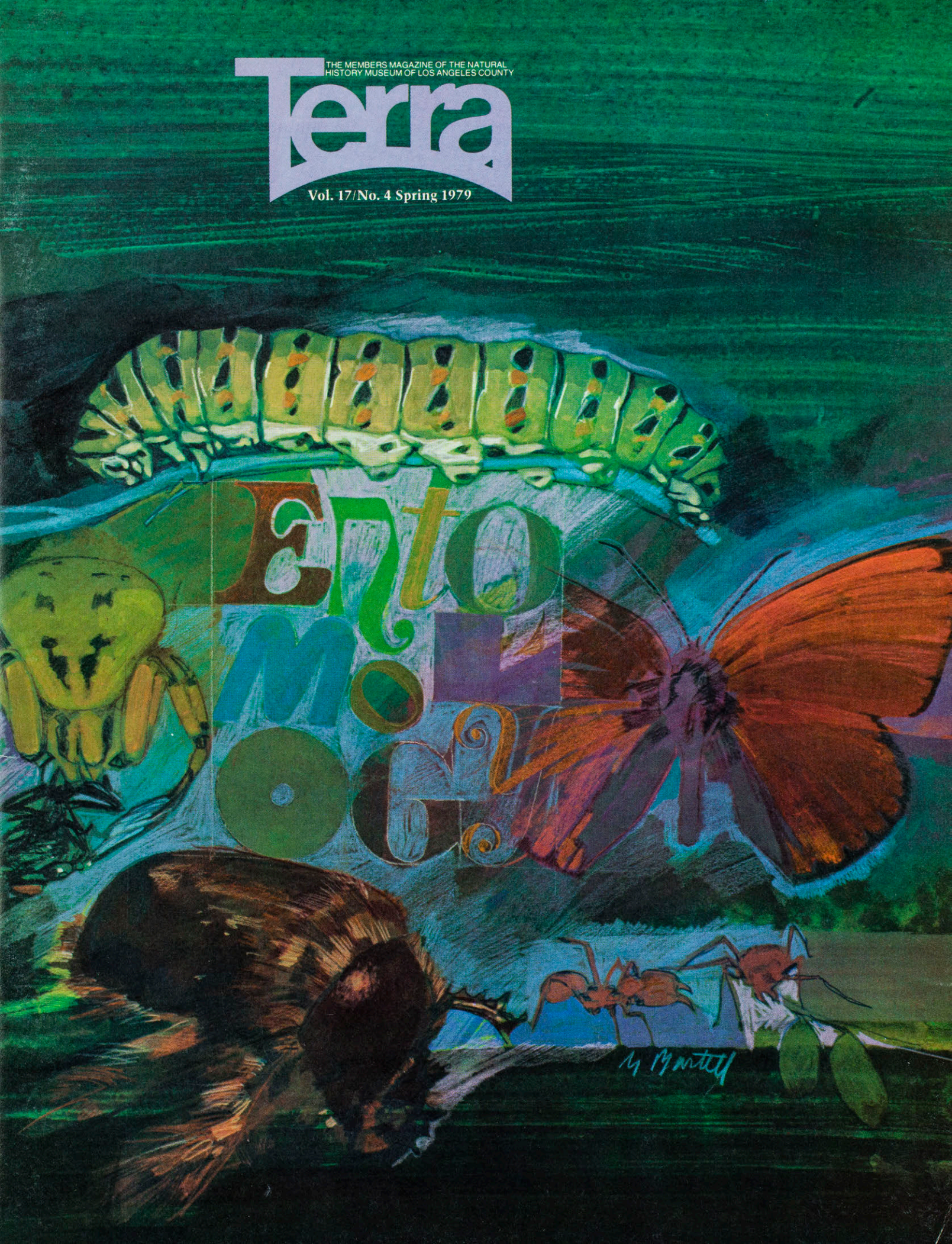
THE MEMBERS MAGAZINE OF THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

Terra

Vol. 17/No. 4 Spring 1979



ENTOMOLOGY
THE EXPLODING SCIENCE

The first page of the earliest popular English textbook of entomology, published in 1815 by William Kirby and William Spence, laments the sad state of the science: "In such conflict for pre-eminence I know no science that, in this country,... has come off worse than Entomology: her champions hitherto have been so few, and their efforts so unavailing, that all her rival sisters have been exalted above her;..." Though these words were directed towards the British audience of the time, their appropriateness really extended throughout the world, and held their pertinence for 150 years.

The importance of knowledge about insects began to be realized by government and the people as a result of the grasshopper plagues of the 1870's and 80's in the United States, and a score of years later when it was discovered that insects were vectors of human disease. Still, it has taken two world wars and a global population explosion to wake the sleeping giant that is entomology. While a generation ago it was possible for an entomologist to possess a working familiarity of the field, today's research activity and literature have swollen to such enormity that extreme specialization is a necessity for anyone to carry the title "expert." This is particularly true in the disciplines of agricultural and medical entomology, insect physiology and control, behavior and systematics. The Zoological Record (the main bibliography of literature on animals) recognized only 133 general subject categories under entomology in 1950; the latest complete (1972) volume lists over 700!

Although our space is extremely limited, we authors of this special topical edition of TERRA are attempting to convey something of the diversity and modernity of the study of insects.

Julian Donahue reveals to us the intriguing protective adaptations and unsuspected beauty of caterpillars, and we are reminded that for the more than twelve thousand species of Lepidoptera in our country alone, the larvae of only a minute percentage have even been discovered. Basic biological knowledge of insects is still being contributed significantly by the amateur—a tradition in entomology—as demonstrated by Frank Hovore's work on rain beetles. Also increasing is our understanding of social insects; in this area Chris George reviews her recent research on the trophic ecology of desert fungus-growing ants.

Although technically outside the category of insects, spiders and their relatives have customarily been included among the responsibilities of the entomologist. Thus it is appropriate for Mel Thompson to bring spiders into our review, which he does with an introduction to the common kinds we are likely to encounter in Los Angeles.

A mark of maturity in any science is introspection. Thus, Jeannine Oppewall shows us a bit of history of the subject, made in California by the butterfly farmers. And in a lighter vein, as a student of "cultural entomology" (the influence of insects on man's attitudes towards nature), Dr. Hogue introduces us to some fantastic insects who populate our literature and mythologies.

With our few pages we hope we will do for the reader in some small way what Kirby and Spence resolved to do so long ago with their book: "...to introduce their countrymen to a mine of pleasure, new, boundless, and inexhaustible;..." by exploring the exciting avenues through the insect domain.

THE MUSEUM'S ENTOMOLOGY SECTION

Central to the function of the Entomology Section is its collection of insects and related terrestrial arthropods (spiders, ticks, scorpions etc.). The collection is one of the ten largest in North America, presently with about three-and-a-half million specimens, and growing at the rate of over a hundred thousand annually.

The majority of the specimens are stored in glass-topped drawers which rest on shelves built into a modern movable module storage system (designed to maximally utilize the floor area available by eliminating fixed aisles and providing access by moving carriages.) The installation, one of only three currently in operation in the country for an entomological collection, was made possible by grants from the National Science Foundation and the Museum Foundation.

The material resources of the Section, in addition to the collection itself, include an extensive branch of the Museum's main Library, as well as photographs and archives, which provide an invaluable source of information on insects to the residents of Los Angeles County and workers in all parts of the world. The staff handles hundreds of inquiries annually, which may consist of simple questions on the identity of a household pest to complex reports on the insect fauna of a particular geographic area.

The collection and associated reference materials are open and available for use (by appointment for visitations or by loan to others) by qualified amateur or professional entomologists anywhere in the world. In 1978, the Section logged 426 visitors and shipped out on loan more than 14,540 specimens to sixty-two workers.

Although the staff is attempting to build a representative worldwide collection, past and present interests of donors and curators have resulted in certain portions becoming stronger than others. Present strengths include the world's largest assemblage of butterflies and moths of the southwestern United States, second largest collection of ants in North America, and an especially large and fine holding of aquatic insects from California. Outstanding too are the collections of aquatic and semi-aquatic bugs from around the world; twisted-wing insects (Strepsiptera); social bees and wasps from tropical and North America, as well as many others.

The Museum's entomologists also are involved actively in research, teaching and exhibition functions within the Museum as well as in outside activities for both the lay and scientific communities. Contact is made through lectures, school tours and classes, and correspondence.

This expanded edition of TERRA devoted to Insects is larger and more colorful than usual because of the warm generosity of Mrs. Maurice Machris, whose contribution made this special issue possible.

Terra®

The Members Magazine of
THE NATURAL HISTORY
MUSEUM ALLIANCE
of Los Angeles County
VOL. 17/No. 4 Spring 1979

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Collage Illustration by George Bartell. This is the fifth TERRA cover that noted illustrator Bartell has generously contributed to the Museum.

Printed by North Hollywood Printing Co., Inc.

Color separations by Computer Color Corp.

Typography by R S Typographics

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STRATEGIES FOR SURVIVAL

THE CAUSE OF A CATERPILLAR

By Julian P. Donahue

Butterflies and moths comprise the second largest order of insects, the Lepidoptera. Of the more than 125,000 species in the world, ten percent occur in North America north of Mexico. The diversity of their size, form and color seems endless. And, since they often come in contact with man, we judge many of them by their actions or appearance with appellations such as "beautiful," "ugly," "pests," or "indifferent." Consequently, they are the object of a great deal of observation and study.

But for every butterfly or moth there is a caterpillar. Since Lepidoptera have complete metamorphosis, the life cycle consists of four discrete, totally different life forms: egg, larva (or caterpillar), pupa (often called a chrysalis in the case of butterflies), and adult.

Caterpillars can be just as beautiful, or ugly, or nondescript, as an adult butterfly or moth. Surprisingly, however, some of the most strikingly colorful or bizarre caterpillars develop into the most ordinary-looking adults imaginable. Conversely, some of the dullest, most uninteresting larvae turn out to be butterflies or moths that attract the attention, if not the admiration, of even the most casual of observers.

A number of caterpillars are notorious for the destruction they cause to crops and stored products. Much less appreciated, however, is the fact that some caterpillars are considered to be beneficial. The domestic silkworm, *Bombyx mori,* is perhaps the best known of these. Other caterpillars are consumed as food, sometimes as a novelty: I was surprised to discover, however, that the can of "fried caterpillars" I once sampled actually consisted of roasted, salted pupae, not larvae, of Japanese silk moths! Caterpillars are frequently used in the classroom to illustrate insect metamorphosis, and now some caterpillars are being imported and released in biological control programs. For example, the European Cinnabar Moth *(Tyria jacobaeae)* has been released in Canada and the western United States to aid in the control of tansy ragwort *(Senecio jacobaea),* a weed which is poisonous to livestock. And the State of California is experimenting with a species of *Coleophora* moth as a potential control agent for Russian thistle (tumbleweed).

For the most part, however, we are oblivious to the caterpillars which abound around us. Perhaps not so surprising, then, is the fact that the caterpillar stage of many of our butterflies and moths is either completely unknown or has been poorly described. This lack of knowledge only serves to stimulate the inquisitive—hence the lure of the caterpillar: discovering the life cycle of a species is one of the exciting challenges of modern biology. Some caterpillars illustrated here are figured for the first time, and most of the others have never been figured in color.

Caterpillars are remarkably uniform in basic structure. Although the body is divided into three regions, as in the adult, only the head is distinctively different from the thirteen fleshy segments behind it. The capsule-like head bears a pair of minute antennae, usually some simple eyes, and the mouthparts—of which the opposable, chewing mandibles are most conspicuous. The next three segments form the thorax, usually characterized by the presence of a pair of short, claw-tipped, segmented legs on each segment. Besides aiding in locomotion, these legs are also used to manipulate (or even capture) food. The remaining ten segments constitute the abdomen. They are all rather similar in appearance, except that segments three to six and ten usually have a pair of ventral, fleshy "prolegs" which are tipped with an array of hook-like "crochets" (because of their resemblance to crochet hooks). The configuration of these crochets is quite variable and is a useful aid in identification.

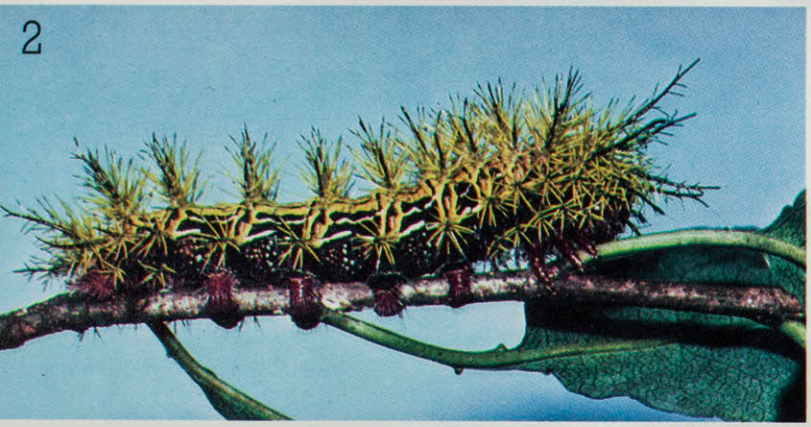
In the Lepidoptera, as in other insects with a larval stage, all growth takes place as a caterpillar; there is no such thing as a "baby" moth or butterfly—if it has wings, it will never grow larger. This growth is accomplished through a series of moults, usually about half a dozen, when the skin is shed to reveal successively larger "instars" or stages. And the amount of growth is truly impressive: from newly-hatched to full grown, the larva of the Polyphemus Moth *(Antheraea polyphemus)* increases in weight some 4,140 times, while a European carpenter moth *(Cossus cossus)* increases its weight a phenomenal 72,000 times! (In comparison, an adult human weighs only about twenty-two times as much as he did as a newborn infant). Full grown larvae also can vary considerably in size, from a length of less than 5mm, in the case of some leaf miners, to 135mm or more (over five inches).

A caterpillar's sole role in life is to garner and store enough nourishment to fuel the transformation to, and sometimes the total energy requirements of, the adult insect (many adult moths are actually physically incapable of feeding). But what goes in must come out. Caterpillar excrement consists of relatively dry pellets termed "frass." The presence of frass on the patio is often the first clue that something is munching on the geraniums, while many tomato growers have noticed the characteristic, hand-grenade-like pellets of the tomato hornworm. And not even frass is immune to scientific inquiry: one student, working with European species, found that a full grown larva of a sphinx moth, *Pergesa elpenor,* dropped only forty-six pellets during its final instar, while the much smaller gelechiid, *Chimabacche fagella,* expelled an incredible 1,201 pellets during its last instar. "Frass rains" can occur during periods of unusually high larval populations, when the sound of falling pellets cannot be ignored, especially when they drop on a tent or the dry leaves of the forest floor.

Although all caterpillars chew their food, *what* they chew is a source of constant amazement. Most caterpillars can be categorized by their food habits as plant feeders, scavengers or predators.

VEGETARIANS The vast majority of caterpillars are vegetarians. Lepidoptera and plants have evolved in parallel, and it seems as if caterpillars have exploited every possible plant food resource—no matter how toxic, formidable, or inaccessible it may be: nettles, cactus, thistles, poison ivy and poison oak, milkweed, and numerous other plants which are toxic not only to most other animals, but to most other insects

Captions for these photographs appear in columns 2 & 3 on page 7.



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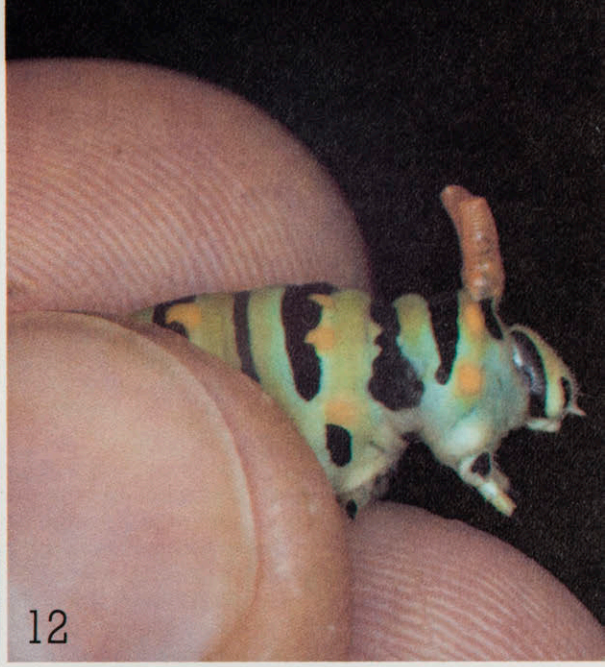
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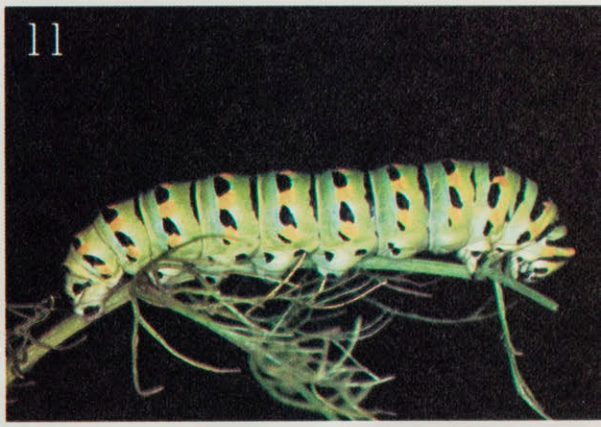
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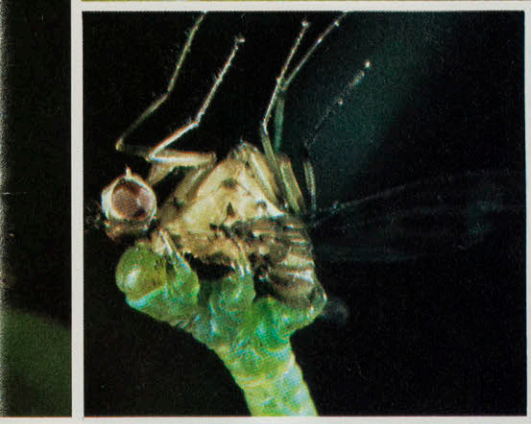

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as well. Most of the better known caterpillars consume the entire leaf, but others eat only the epidermis and leave the veins (skeletonizers), or feed only *inside* the leaf, between the upper and lower epidermis (leaf miners), even in such unlikely leaves as pine and juniper needles.

Besides feeding on leaves, caterpillars can be found on or in virtually every other part of a plant which offers any nutritive value whatsoever: flowers, fruits of all sorts (including grains, seeds, and nuts), roots, stems, twigs, etc. Many larvae feed internally in the plants (borers), while others form characteristic galls on various parts of the roots, stems or leaves. The majority of phytophagous caterpillars are very choosy about their food: they rely on a single species of plant, or a group of closely related species of plants, for their sustenance (see "Take a Butterfly to Lunch" in the Winter 1976 issue of *Terra*).

SCAVENGERS The scavengers, usually the larvae of smaller moths, feed on virtually every kind of dead organic material. Some are specialized, such as the African tineid *(Ceratophaga)* that feeds on horns and hooves, or another tineid that is usually associated with manure. Others, however, occur in a wide variety of habitats, from leaf litter to bird nests, where they apparently feed on any suitable organic material, although the precise feeding habits need much clarification. The best-known scavengers are those which have come into conflict with man by consuming his stored products: raisins, grain, candy bars, nuts, dog food, dried fruits, cereal, flour, dried chiles and so on. The clothes moths, whose larvae attack wool, skin, fur and feathers, are also considered to be serious pests.

CARNIVORES Much less numerous, but exceedingly interesting, are carnivorous caterpillars. Cannibalism, most likely in response to overpopulation, has been documented in a number of cases, particularly under the artificially crowded conditions of a rearing container—much to the chagrin of the person attempting to rear them. Less well known is the fact that a number of caterpillars are truly predatory under normal conditions. This unusual behavior has evolved independently in a wide range of butterflies and moths.

Several species of lycaenid butterfly larvae feed on ant larvae, while the Harvester Butterfly *(Feniseca tarquinius)* of eastern North America, also a lycaenid, feeds on woolly aphids. Larvae of the pyralid moth genus *Chalcoela* feed on the larvae of *Polistes* wasps, whose familiar nests hang from many an eave. Although this peculiar choice of food appears to be beneficial, as it would tend to reduce the population of wasps around human habitation, it is actually detrimental in agricultural areas where the wasps are encouraged because they prey on caterpillar crop pests. Thus, we have the unusual situation where caterpillars feed on, and are fed upon by, wasps. Other species of pyralids, notably in the genera *Laetilia* and *Macrotheca*, are predators on various kinds of scale insects.

Can there be any more bizarre examples of predation than those above? Perhaps the larvae of the moth families Epipyropidae and Cyclotornidae have the most unusual and unlikely feeding behavior: they are external blood-feeding parasites that live under the wings of fulgorid and related bugs. I say "perhaps" the most unusual, for there are many strange things yet to be learned about larval nutrition. (For example, recent unpublished observations found that the larvae of the pyralid sloth moth feed on sloth dung, but we can still only speculate about why the adult moths live in the fur of the sloth).

ADAPTATIONS FOR SURVIVAL The life of a caterpillar can be as short as a few weeks, as in some leaf miners, or as long as four years or more, in the case of some of the carpenterworms (Cossidae). Because of their generally sedentary nature, caterpillars are vulnerable to a wide variety of threats to their life, and have evolved an elaborate variety of mechanisms to prevent or reduce the chance of death by predators, parasites, diseases and accidents. Unlike the adult butterfly or moth they will become, they do not have the power of flight as an option for escaping attack.

A very common type of defense is to be invisible to your enemies, which explains in part why the casual observer seldom sees caterpillars in the first place. A caterpillar may be physically invisible because of where it is feeding, as inside a root or stem. More likely, however, the larva is cryptically colored, or camouflaged, to match its surroundings, or resembles an innocuous object, such as a twig or a bird dropping.

Entire books have been devoted to the many defense mechanisms of insects. The accompanying photographs illustrate some of these defenses, which can be broadly categorized as physical, chemical, or behavioral. A few examples will illustrate the multitude of mechanisms for survival, some of which can not be neatly pigeonholed into a single category.

PHYSICAL DEFENSE Larvae of the moth families Psychidae, Mimallonidae and Coleophoridae are well-known, among others, for their ability to construct portable "homes." Solitary larvae in many diverse groups form protective shelters by rolling or tying leaves together, while a number of communal species manufacture and live in a common web or nest (Fall Webworm, *Hyphantria cunea;* Tent Caterpillar, *Malacosoma* species; Mourning Cloak butterfly, *Nymphalis antiopa*).

Physical protection is also achieved in many groups by a varying array of hair-like setae, spines, and filaments which may serve to make the larva appear inedible or otherwise not worth the effort to a potential predator, or may make it more difficult for parasites to lay eggs on the skin itself.

CHEMICAL DEFENSE Besides having an objectionable odor (the European "goat moth" larva), or combining an odor with a threatening eversible organ (swallowtail butterfly larvae), some caterpillars are downright poisonous. Of course, the Monarch Butterfly *(Danaus plexippus)* is the classic example. Its larvae which have fed upon poisonous milkweed *(Asclepias)* store, or "sequester," the plant's toxic compounds and thereby become toxic themselves to any unwary predator. Larvae of a number of other species also feed on milkweed and related toxic plants, most notably the brightly colored "hairy" caterpillars of the arctiid moth genera *Euchaetes, Pygarctia, Ectypia,* and their allies.

Generally speaking, larvae which are toxic are also conspicuously colored, or aposematic. This "warning coloration" presumably makes it easier for predators to recognize the insects and thus avoid repeating previously unpleasant encounters. Besides the milkweed family (Asclepiadaceae), several other families of toxic plants are well known for their aposematic herbivores, including the Euphorbiaceae (spurge family), Solanaceae (tomato family), Aristolochiaceae (Dutchman's pipe or birthwort family), and Apocynaceae (dogbane family).

Even more surprising than the ability to merely sequester toxic compounds with impunity is the ability of some larvae to actually manufacture in their bodies poisonous compounds from the harmless raw materials they ingest. Perhaps the most amazing examples are larvae of the zygaenid moth genera *Zygaena* and *Procris*, which manufacture hydrocyanic acid! (Obviously correlated with this is the resistance of the adult zygaenid moths to the entomologist's cyanide killing jar. Experiments have shown that while other similarly small moths succumb in a few short minutes, some zygaenids survive for over three hours).

As mentioned earlier, hairs and spines provide physical defense for a number of caterpillars. But in some groups these structures are actually poisonous. The most familiar examples are wild silk moths in the subfamily Hemileucinae

(Saturniidae), the puss caterpillars (Megalopygidae), and the saddleback caterpillars (Eucleidae). People vary in the severity of their reactions to these caterpillars, but we seldom forget them. In addition, some people, and presumably other animals as well, have allergic reactions to the urticating hairs of some tiger moth and tent caterpillar larvae, manifested by a nettle-like rash and prolonged itching.

BEHAVIORAL DEFENSE Although caterpillars tend to be rather sedentary as they perform their basic function of eating, they can also exhibit a variety of behavioral activity, particularly if they are under attack. To escape predators, many larvae immediately drop to the ground where they seek shelter, play dead, or run (although I don't know of any comparative studies, I consider larvae of the *Apantesis* tiger moths to be the "fastest worms in the West," although the related eastern *Haploa* may challenge that title). Other larvae may assume a more formidable appearance or make a threatening display, often with the effect heightened by eye-like spots or the sudden exposure of brightly colored bands of intersegmental skin.

As mentioned earlier, some larvae are communal, at least in their earlier stages, a type of behavior usually associated with aposematic or nest-making species. And some larvae escape detection by feeding only at night, becoming motionless and cryptic by day when the majority of vertebrate predators are active.

Myrmecophily, or the association with ants for protection, is best known in the butterfly families Lycaenidae and Riodinidae. This complex association, with its many variations, can involve many relationships, some of which are often cited as examples of mutualism or symbiosis. In its most simplistic form, the caterpillars secrete a substance attractive to ants, much like the honeydew of aphids; in "return," the ants protect their source of food from the attack of predators and parasites. There are numerous exceptions and complications in these relationships, which continue to be the subject of continued research.

Despite the remarkable adaptations for survival that we see in caterpillars, they are only barely sufficient to ensure the continuation of the species, at least for the moment. Every defense can be breached—otherwise we would be up to our armpits in butterflies and moths. If the defender cannot evolve a new defense, the species will perish in the constant struggle for survival—nature's equivalent of the arms race. Observing and attempting to understand these adaptations for survival is what makes caterpillars so much fun.

Poisonous spines are characteristic of several species of wild silk moths (Saturniidae). **1** Saturnia walterorum, *photographed in San Diego Co., California by Paul M. Tuskes;* **2** Automeris zephyria *from Sunspot, New Mexico, reared in South Carolina on* Prunus serotina *by Richard S. Peigler and photographed by G. R. Carner;* **3** Automeris io, *the well-known Io Moth of eastern North America, photographed in Amherst, Massachusetts by Paul M. Tuskes;* **4** *Larvae of the Io Moth are gregarious in their early stages (photographed in Amherst, Massachusetts by Paul M. Tuskes).*

Not all wild silk moth larvae have poisonous spines. Despite their gaudy coloration, these two are harmless to the touch (whether they taste bad to predators has probably not been determined). Both photos by Paul M. Tuskes. **5** Sphingicampa hubbardi, *from Pima Co., Arizona;* **6** Eupackardia calleta, *from Ajo, Arizona.*

Many, if not most, larvae which feed on poisonous plants are poisonous or distasteful themselves. Those which "advertise" this fact by being brightly colored are called aposematic. **7** Erinnyis ello *(Sphingidae), the Ello Sphinx, is occasionally a pest on poinsettia. Photographed on Plantation Key, Florida by Paul M. Tuskes;* **8** Ectypia clio *(Arctiidae), the tiger moth that's "been to the beauty parlor." Reared in Prescott, Arizona on milkweed* (Asclepias) *by Lloyd M. Martin and photographed by Julian P. Donahue;* **9** Pygarctia roseicapitis, *another milkweed-feeding tiger moth. This one, from Madera Canyon, Santa Rita Mountains, Arizona, was reared on poinsettia and photographed by Julian P. Donahue (JPD #71–34);* **10** Syntomeida epilais jucundissima, *the Oleander Caterpillar of Florida, photo courtesy of L. N. Brown.*

Despite their conspicuousness on film, many caterpillars are virtually invisible in their native haunts, and sometimes have a vastly different appearance during different stages of growth. **11-12** *Larvae of swallowtail butterflies, for example, often look like bird droppings when young, and later acquire startling eye-like spots or bright colors. They all possess a unique forked osmeterium behind the head, an organ which emits a pungent odor when it is everted if the caterpillar is disturbed. This larva of the Anise Swallowtail* (Papilio zelicaon) *is from Corona del Mar, California, photographed by Julian P. Donahue (JPD #71–30). Here the osmeterium is only partly everted.*

Measuring Worms, or Inch Worms, larvae of the moth family Geometridae, are remarkable for their cryptic coloration and behavior. They "loop" instead of "crawl" because they have lost three pairs of abdominal prolegs. **13-14** *Two unidentified larvae, possibly the Omnivorous Looper* (Sabulodes aegrotata), *feeding on poison oak* (Toxicodendron diversilobum) *in Los Angeles, California, photographed by the author. The one on the left, about 1¼ inches long, is in the typical twig-like resting posture; the one on the right, less than ¾ inch long, is an even better mimic in having a color similar to that of the petiole of the foodplant.* **15-16** *Larvae of the geometrid subfamily Geometrinae go one step further: they have the ability to fasten bits of the foodplant to hooks at the tip of the protuberances on their back, thus increasing their concealment even more. The adults of these moths are the well-known "Emeralds," because of their usually bright green color. Both photographed by the author.* **15** Cheteoscelis bistriaria *on its foodplant,* Chrysothamnus nauseosus mohavensis, *collected near Pearblossom, California and reared by Chris Henne (JPD #73–12).* **16** Synchlora liquoraria liquoraria, *discovered feeding on mint* (Mentha) *flowers in his backyard in Woodland Hills, California, by F. Sidney Badger, who reared it to the adult moth to verify its identity (JPD #74–7).*

Predatory food habits in the Geometridae were apparently unknown until January, 1972, when Steven L. Montgomery observed the larva of Eupithecia orichloris *feeding on a large calliphorid blowfly on Hualalai Volcano on the Big Island of Hawaii. "Subsequent laboratory observations," he writes, "confirmed that large flies were actually seized when moving near the posterior end of the poised caterpillar. The (thoracic) legs, especially the tarsal claws, are elongated and bear heavy spines so that, when extended, they form a basket with which the prey are enclosed by means of an instantaneous backward reach."* **17,** *a full-grown (one inch long)* Eupithecia staurophragma *beginning to feed on a large (quarter inch long) female fruit fly,* Drosophila heteroneura. **18,** *close-up detail of* Eupithecia orichloris *beginning to feed on its freshly-caught prey, a male* Drosophila conspicua. *(Both photographs courtesy of William P. Mull).*

Many larvae of the metalmark butterflies (family Riodinidae) have "honey glands" near the posterior end of the abdomen that secrete a fluid attractive to ants. This species, Juditha molpe, *which is remarkably camouflaged due to its resemblance to the petioles and leaf scars of the unidentified tree on which it was feeding, was photographed by the author on the Osa Peninsula, Costa Rica. David B. Weissman subsequently observed the larvae and their interaction with the stingless ants which were tending them,* Monacis bispinosa. **19,** *lateral view of an ant astride a larva;* **20,** *close-up detail, dorsal view, of an ant removing liquid from the honey gland. (JPD #71–9)*

21 *A second riodinid, an unidentified species of* Menander, *also from the Osa Peninsula, Costa Rica, discovered feeding on the leaves of salty mangrove* (Pelliceria rhizophorae) *by James Collins; reared and photographed by the author (JPD #71–10). The extremely flattened larva is so translucent that one can see the digestive tract running down the center of the body (head at the top), and the paired testes near the center of the body. The four white spots are spiracles; the inconspicuous honey glands are adjacent to the posterior pair of spiracles. Collins observed* Azteca *ants tending the larvae. Note that the bilobed pronotum conceals the head.*

22 *A "puss caterpillar" (moth family Megalopygidae), notorious for their urticating setae. Photographed by the author on the Osa Peninsula, Costa Rica.*

23 *An unidentified bagworm (moth family Psychidae), probably* Oiketicus kirbyi, *feeding on* Citrus *on the Osa Peninsula,*

Captions for photographs 19–23 appear in column 3, page 7.

Costa Rica. Only the head and part of the thorax of the large larva (about three inches long) are exposed during feeding. The larva withdraws into the stout case at the slightest disturbance. (Photographed by the author; JPD #71–7.)

24 *Dorsal view (head at right) of the strikingly patterned larva of* Gnophaela latipennis, *a day-flying pericopid moth, collected in Yosemite National Park, California by John E. S. Dockweiler. Subsequent specimens were collected by Wallace Pinfold on western hound's tongue* (Cynoglossum occidentale). *The bright coloration suggests that this larva may be distasteful to predators. (Reared and photographed by the author; JPD #72–18.)*

25 *Cocoons of parasitic braconid wasps indicate that, despite external appearances, the wasp larvae have devoured most of the internal tissues of this tomato hornworm* (Manduca quinquemaculata; *Sphingidae), which will soon die. Predators, parasites, and diseases kill a large percentage of the immature stages of Lepidoptera.*

Larvae of many of the tiger moths (Arctiidae & Ctenuchidae) are hairy "bears." Most of them are harmless to the touch, and possibly to the taste as well. They are the favorites of many, particularly school children. One of them, the banded woolly bear (Pyrrharctia isabella) *is even used as a prognosticator of the severity of the forthcoming winter.*

26 *Close up view of the head of Edwards' Glassywing* (Hemihyalea edwardsii), *collected and reared in Riverside County, California, by Robert J. Ford (Photo by the author, JPD #76–5).*

27 Lophocampa (=Halysidota) maculata agassizii, *usually found on willow* (Salix) *in California. Photographed in the San Bernardino Mountains, California, by Charles L. Hogue.*

28 *The Salt Marsh Caterpillar* (Estigmene acrea) *feeds on a wide variety of herbaceous plants, and is sometimes abundant enough to be considered a pest. Widespread in North America, this one is from San Diego, California. (Photo by the author; JPD #71–45.)*

29 *The Yellow Bear* (Spilosoma virginica) *is another widespread, polyphagous, species. This one is feeding on white sweet-clover* (Melilotus albus) *in Barry County, Michigan. (Photograph by the author; JPD #69–22).*

30 *Larvae of some members of the moth family Lymantriidae are called tussock caterpillars, because of their tufts of setae. Some species are considered to be serious pests, but this one,* Orgyia cana, *is usually not abundant enough to be a problem. Collected in San Diego, California, on* Lotus scoparius, *and photographed by the author (JPD #71–13).*

31 *Not all Tent Caterpillars (moth family Lasiocampidae) make tents. This is one that doesn't,* Malacosoma constrictum. *Found on cork oak* (Quercus suber) *in Los Angeles, California. (Photograph by the author; JPD #74–2.)*

Julian P. Donahue, entomologist at the Natural History Museum of Los Angeles County, is curator of over half a million butterflies and moths, one of the largest such collections in the nation. Current research activity is centered on taxonomy and distribution of tiger moths (Arctiidae and related families) and carpenter moths (Cossidae) of the New World, and selected groups of "microlepidoptera."

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RAIN BEETLES SMALL THINGS WET AND WONDERFUL

By Frank T. Hovore

The first faint flickerings of daylight had only just begun to sparkle in the thick, near-freezing fog and drizzle so typical of the Sierra Nevada in winter. Dave Marqua and I stood silently watching while a lone coyote performed a bizarre ballet only a few meters away in a mist-shrouded meadow. Time and again the animal would lower his powerful body into a motionless crouch, muzzle upturned as if sniffing at the cold rain—and then, suddenly, he would lunge sideways and upward, rising several feet into the air. At the apex of each such vault, the snapping-shut of his powerful jaws could be distinctly heard. This routine was punctuated by brief fits of furious digging, which sent up great sprays of uprooted grass and gravelly mud.

Such antics might cause the casual observer to think the coyote had taken leave of his senses. Dave and I, however, knew otherwise, inasmuch as we had come into the meadow with similar intent—to catch the elusive rain beetle not for food, but for study. Soon, as dawn lit the meadow, we too would run, leap and dig to capture our fast-flying quarry.

Rain beetles are large, primitive scarabs of the genus *Pleocoma* ("abundant hair"). Their pre-dawn nuptial flight began at 5:15 a.m. on a bitter-cold, rain-drenched November morning near a tiny hamlet called Sheep Ranch in Calaveras County. Dave and I could hear the first buzzing sounds of the males as they took wing in the tall grass, but we were as yet unable to see them clearly. The coyote, however, by virtue of his superior hearing and night vision, had already begun "collecting." Upon our belated entry into the meadow, he made a silent retreat, pausing only briefly to cast a disdainful glance our way. Our "competition" had snapped-up one female and seventeen males—the number easily deduced by examining the undigested fragments of their tough exoskeletons left behind on the ground. We were to do a bit better that morning, taking a total of thirty-seven specimens, and, in the process, discovering the larval food plant. This particular species of rain beetle, *Pleocoma blaisdelli*, had previously been recorded from but a few male specimens, and virtually nothing was known of its habits—except, of course, by countless generations of coyotes!

Our success with *Pleocoma blaisdelli* on that happy morning was the culmination of a search stretching over three winters and hundreds of slowly-driven miles on narrow, winding mountain roads. We had constructed, deployed and repeatedly

Author inspecting a possible rain beetle burrow in Placerita Canyon. Pleocoma *collectors quickly learn the difference between beetle burrows and those of spiders, scorpions and irritable rodents. (J. Spehar, photo)*

checked numerous ultra-violet light traps (male rain beetles, like some moths, are strongly attracted to light) in likely locations, and had made local inquiry in dozens of small Sierran communities. Our efforts had, to that point, yielded only a few male beetles from beneath street lights, and we had never been able to ascertain from which direction these had come.

Fortuitously, a local butterfly collector had recently brought a few male *Pleocoma* to the Museum for identification; these turned out to be *blaisdelli*, and he told us that they had been collected during a rainstorm at the lighted windows of a trailer somewhere in the vicinity of Sheep Ranch. Following this fresh lead, we conducted a house-to-house (and hillside-to-hillside) search in and around that village. After a long day of fruitless inquiry and poking fingers into every hole-in-the ground that looked even vaguely rain-beetleish, we met an "old timer" (there is one of these marvels in every town, and they *always* know *everything* about *everything*) who recalled seeing "big black bugs" flying around her porchlight on rainy nights. She had, in fact, remembered one falling into her washing machine during the last storm! Soapy, and rotten to the point of disintegration, it was definitely a male *blaisdelli!*

Rain appeared imminent, so we focused our attentions upon the nearest brushy hillsides for any signs of *Pleocoma* activity. At dusk we saw three male beetles flying rapidly over the Buckbrush thickets which line the main road, and so we set-up our camp on a nearby dirt road, adjacent to the aforementioned meadow. The weather was cooperative—it poured all night—and sometime during the night a few male beetles flew into our light trap. We collected the majority of our specimens, however, at daybreak, by netting them from the air or digging them from their freshly-opened burrows in the red clay soil beneath the Buckbrush *(Ceanothus cuneatus)*. By mid-morning the steady rainfall had obliterated all traces of their pre-dawn activity; the males had burrowed to safety in the thick leaf duff; the females had returned to the depths of the earth, and we, with our treasures safely ensconced in plastic vials, began the long drive home.

Author enjoying the comforts of a typical "rain beetle morning" near Bear Divide in the San Gabriel mountains. (M. Wilkerson, photo)

Thus went a successful rain beetle collecting trip. Most "proper" *Pleocoma* trips are equally cold, wet and uncomfortable, but far less profitable. Such is the nature of the beast. Whereas rain beetles may be quite numerous in a particular locality, their "colonies" are often restricted to but a few acres of suitable habitat, and their above-ground behavior can be very unpredictable.

They are among the largest North American members of the Scarab Beetle family, which includes "June bugs," fig beetles, dung beetles and rose chafers. Adult males average about 25 mm (1") long, are shining reddish-brown to blackish in color, and have a dense thatch of silky hair on the undersurface of the body. They possess powerful internal musculature, and are capable of swift, sustained flight. The head is specially modified for digging, armed with a V-shaped scoop on the front, triangular flanges over the large eyes and a sturdy, erect horn on the top. The legs are equipped with "teeth" and scalloped ridges for loosening and moving hard-packed soil. The chestnut-colored females are usually larger (up to 45 mm) and fatter than males, with their only real purpose to serve as egg-laying machines. Lacking functional wings, their digging structures are more pronounced than those of the males—physical testimony to the fact that they may never leave the soil.

Rain beetles occur in scattered subterranean colonies from the Oregon-Washington border south to extreme northern Baja California, Mexico. Most of their lifetime is spent as larvae (called white grubs), feeding upon the roots of a variety of plant species. Habitat preferences vary considerably, but the general tendency is for colonies to be located in heavily-forested areas or on brush-covered, north-facing hillsides with well-consolidated soils.

The annual adult emergence from the soil is closely correlated with the onset of the winter rains (hence their common name), although it is not known for certain which climatic factor (or combination of factors) actually triggers activity. Depending upon the species and the locality, adult rain beetles tunnel upward through the earth in late fall or early winter, opening their burrows to the surface during or shortly after the first soaking rains. Species inhabiting higher ele-

Mating pair of Pleocoma badia hirsuta. *The long "feet" of the male act as grappling hooks, allowing him to cling to the larger female during mating. (M. Wilkerson, photo)*

Male Pleocoma hoppingi *from Calaveras County. The head horns and toothed legs assist in digging through frozen soil, while the dense body hairs prevent abrasion, retain body heat and keep the leg joints free of mud. (F. Hovore, photo)*

vations may not emerge until well into the winter season, apparently in response to melting snow or unusually warm "tropical" storms. Although technically considered "cold-blooded" (as are all insects), rain beetles evidently increase their body temperature by rapidly vibrating the internal muscles of the thorax. Thus they are able to sustain normal activity levels at sub-freezing temperatures. I have netted males in flight during a snowstorm at −1°C. (30°F.), and a male has been observed flying over snowpack above 10,000 feet (3,300m) elevation at −6°C. (20°F.)!

The timing of male flight periods is irregular, with most flights lasting from but a few minutes to several hours, and regularly *not* occurring when most expected, under seemingly "ideal" weather conditions (despite the frantic incantations and exhortations of half-frozen, would-be collectors). Once free from the earth, male rain beetles fly in search of the flightless females, using their fan-like antennae to follow a sexually-attractive odor. They are capable of tracking this odor (called a pheromone) over considerable distances and through dense vegetation. Once they have effectively "zeroed in" on the whereabouts of a female beetle, the males drop to the ground and negotiate the final few inches on foot (or, more correctly, on tarsus). So alluring is the scent that dozens of prospective suitors often approach a single female, and, in their ardor, they may tunnel completely through potential rivals—and even through the female herself. Winter-active animals such as coyotes, foxes, skunks and raccoons are also quite adept at locating female *Pleocoma*, and many a rain beetle romance has met an untimely conclusion in the jaws of one of these predators. Birds and rodents regularly capture and eat the flying males, and California Indian tribes living in rain bettle areas reportedly relished them as a seasonal supplement to their diet. The fat, egg-filled female beetles must have been an especial treat during the lean winter months.

Subsequent to a successful mating, males may again take wing, perhaps to find another female; perhaps to be food for a hungry predator; or, perhaps to quietly die beneath loose soil and leaf litter, their bodily resources exhausted. Adults lack working mouthparts, and cannot feed. Their longevity is therefore dependent entirely upon stored fat deposits within their body, accumulated while still in the larval stage. Females, owing to their larger overall size, greater area for fat storage and less consumptive behavior, may survive underground until the following spring or summer. Then, upon the maturation of their ova, they commence egg-laying. The first pea-sized, white egg is laid near the bottom of the female's burrow, perhaps as deep as three meters. The female covers the egg with a thin layer of pulverized soil, upon which she lays the next egg—and so on, in spiral fashion, up the burrow until all forty to fifty eggs have been deposited. Eggs laid, her life's purpose fulfilled and her energy gone, she dies.

Rain beetle eggs take about two months to develop, and the newly-hatched grubs are less than 10 mm long. They possess strong legs and powerful jaws which allow them to move through the soil in

Males of Pleocoma b. badia *approaching the female at her burrow. They have located her by "tracking" her scent (pheromone) with their large, fan-like antennae. (M. Wilkerson, photo)*

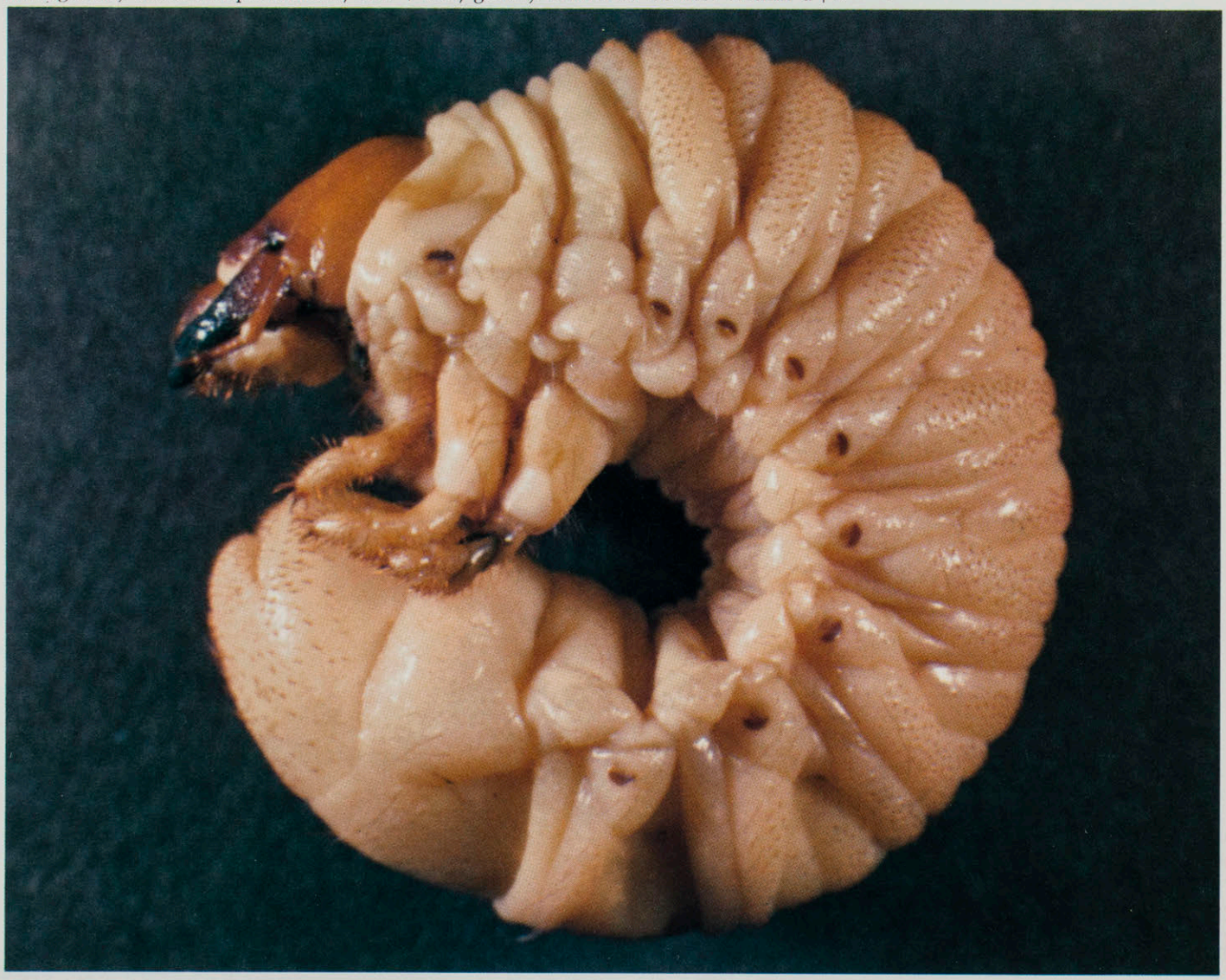
search of food. In loose soils, they evidently tunnel continuously, devouring small rootlets and deeply scoring the surfaces of large roots; in harder, clay-based soils the larvae appear to be less mobile, feeding externally upon large root-tissue nodules. These nodules are tumor-like growths, similar in appearance to those produced in some plants by gall insects, and are possibly formed in response to *Pleocoma* larval feeding activities. Details of larval behavior, food preferences and methods of feeding are very poorly known for most species. In Oregon, where some rain beetle species have transferred their larval feeding from native plants to orchard trees, the larval biologies have been intensively studied, and it is known that the preferred "normal" host plants are Douglas Fir, Yellow Pine and Great Basin Sagebrush. In the recent, man-created absence of the native hosts, rain beetles have demonstrated their adaptability by readily munching the roots of strawberries, pears, apples and cherries. Moreover, under the artificial homogeneity of orchard plantations, rain beetles can attain much greater-than-normal population densities. In one instance, in a Hood River apple orchard, *Pleocoma* occurred at a density of 7.78 grubs per square foot, or 338,800 per acre! Needless to say, under such circumstances, rain beetles have been considered serious economic pests, severely reducing the vigor and productivity of the orchard trees. (Despite this, *Pleocoma oregonensis* has recently been nominated for the Oregon state insect.)

Pleocoma larvae moult their entire outer skin once each year to accommodate a new growth stage, or instar. The larval life span may extend for as many as thirteen years, with female grubs growing to 70mm or more in length and 20mm in diameter. The final instar does not feed, becoming pale and flaccid prior to moulting into the pupal or "resting" stage. The pupal stage lasts for but a few weeks, usually in late summer, and it is from the pupa that transformation to the adult insect takes place. Freshly transformed rain beetles are pale and waxy-appearing, with soft, greatly distended bodies. Within a few days, they acquire their mature coloration and outer-body hardness, and are ready to emerge. Come the rains of winter, moved by forces as yet not fully understood by man, they will rise to participate in one of the insect world's most demanding events, the flight of the rain beetle.

Frank Hovore has been pursuing rain beetles for the past ten winters, having "gotten the bug" while still in college.

In addition to rain beetles, Frank collects and studies longhorned beetles (family Cerambycidae), and maintains strong interests in reptiles and birds. He is a supervisor in the Natural Areas Division of the Los Angeles County Department of Parks and Recreation, currently headquartered at Placerita Canyon Nature Center near Newhall.

Mature grub (larva) of Pleocoma badia hirsuta *dug from the soil beneath Canyon Oak* (Quercus chrysolepis). *The stout legs and large jaws are clearly visible. (F. Hovore, photo)*



DESERT FUNGUS-GROWING ANTS

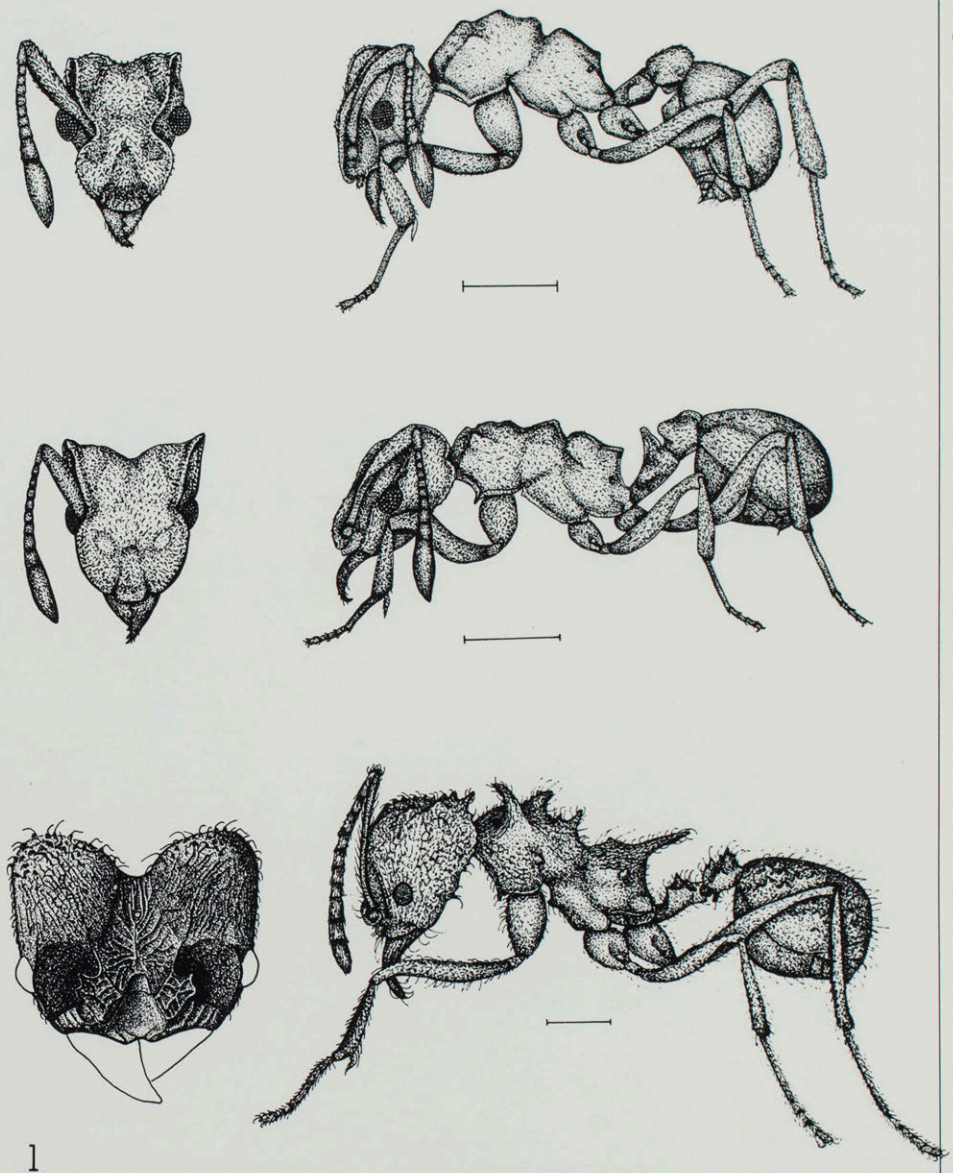


Figure 1. Top: Cyphomyrmex rimosus; *Middle:* C. wheeleri; *Bottom:* Acromyrmex versicolor. *Scale line=0.5mm.*

By Chris George

Although many desert ants are granivorous or predaceous, the majority are generalized in their feeding habits, taking seeds, arthropods, plant exudates and honeydew for food. In our California deserts, however, we have three very unusual species (Fig. 1) which feed on fungus cultivated within their own nests. Our most common and largest species of "gardening ant" *(Acromyrmex versicolor)* cuts leaves from local desert plants and takes them back to the nest where they are treated and then used as a substrate on which they grow their fungus "gardens." These ants, also called "leaf-cutters," are close relatives of the "parasol ants" of tropical America.

Acromyrmex versicolor workers are spiny and not at all small as ants go. They range in size from one tenth to one quarter inch long and prefer desert wash habitats (Fig. 2) populated with ironwood, palo-verde, mesquite and other plants characteristic of wash woodlands. Here, the level of soil moisture, so critical to the survival of the fungus garden, is higher than in most other regions of the desert.

These ants form conspicuous mounds with large uniform craters about four to twelve inches in diameter (Fig. 3). A nest of *Acromyrmex versicolor* excavated in a desert region of Arizona was found to have a number of interconnecting galleries just beneath the surface which eventually led down to a small chamber containing a fungus garden. The garden consisted of a fine leaf-pulp substrate with a mass of white fungal filaments (mycelia) growing on top. The brood is imbedded in this fungal mass and can thus feed at will.

The workers of this unusual species leave the nest in the morning and again in the afternoon to forage during cooler parts of the day. They travel in files (Fig. 4) along paths or trails that lead to the desert shrubs or trees they will utilize.

Once at a foraging site, the workers climb a plant, move out on the branches and begin cutting leaves (Fig. 5). If the leaf is large, only a portion of it will be removed. Once a leaf has been selected, the hind legs are used for leverage and support (Figs. 5 and 6) while the mandibles, which possess fine teeth on the cutting edges, function like scissors, clasping the leaf and cutting out a piece. Leaves of desert plants are generally small enough to be taken intact once the petiole is cut (Fig. 6). The plants which populate the wash woodlands where *Acromyrmex versicolor* nests are leguminous for the most part, and often have leaves comprised of a group of tiny leaflets (Fig. 7). The workers cut entire leaves as well as the leaflets from these legumes, but often require assistance to transport a whole leaf back to the nest (Fig. 7). Besides leaves, they collect stems and flowers from the trees and shrubs of the wash (Figs. 4–9). They also take seed coats and pod fragments.

When large portions of a colony concentrate their efforts on a particular tree or shrub, it may be completely defoliated. I once observed a large group of foragers at work on a boxthorn *(Lycium andersonii)*. They stripped this shrub systematically, beginning at one side and moving across toward the center. At that point the shrub looked like a half-decorated Christmas tree.

Once the leaves are brought into the nest, they are "processed" by workers whose function it is to tend the garden. The plant material is licked, cut into smaller pieces, and masticated. These degraded fragments are then inoculated with fungus from other parts of the garden. Both salivary and anal excretions are continually applied to the garden as fertilizers beneficial to the growth of the fungus. The transplanted fungal filaments grow rapidly and cover the plant

matter within twenty-four hours. Each filament develops an inflated tip or gongylidium which is the portion of the fungus actually eaten by the ants. Consisting of carbohydrates, protein and lipids, it provides them with a complete and well-balanced diet. Thus, the fungi, which are able to degrade cellulose, convert plant material which is readily available, but indigestible by ants, into a useful nutrient upon which they can live.

Since gardens are cultivated using bits of fungus already existing in the nest, you may wonder how a garden is started when a new nest is founded by a queen. The reproductive female takes bits of the parental nest fungus and tucks them away in an infrabuccal pocket (a cavity under the opening of the esophagus) before emerging from the nest for the mating flight. After insemination, the queen drops to the ground, casts off her wings and begins digging a nest in the soil. Colony foundation has been most extensively studied for the leafcutter *Atta*. In this group of ants the queen constructs a narrow tunnel which descends vertically anywhere from six to twenty-six inches and terminates in an enlarged blind chamber. Here the queen ejects her wad of fungus and a garden is usually established within twenty-four hours. The queen lays eggs on the garden as soon as it starts to grow. It is hypothesized that the fungus-culturing habit evolved after ants began utilizing the fungi they found growing in the nest on their own feces. Since another desert leafcutter, the primitive *Cyphomyrmex rimosus* (Fig. 1) uses insect feces as a substrate for cultivating fungi, this theory does not seem unlikely.

The distribution of leafcutting ants is primarily tropical and our desert populations are limited, probably representing relicts of the Tertiary period when these regions were less arid.

Figure 2. Desert wash habitat showing ironwood, smoke tree, palo verde.
Figure 3. Nests of A. versicolor.
Figure 4. Foraging column of A. versicolor *returning to nest with leaves.*

Figure 5. A. versicolor *worker on boxthorn* (Lycium Andersonii). *Hind tarsi brace the ant.*

Figure 6. A. versicolor *worker reaching out with open mandibles to cut petiole of leaf on boxthorn.*

Figure 7. Two nestmates approaching A. versicolor *to assist with transport of palo verde leaf* (Cercidium floridum) *to nest.*

Figure 8. Stem and leaflets of a legume being transported back to nest of A. versicolor. *Note the difference in size of this polymorphic species.*

Figure 9. A. versicolor *forager carrying dried creosote* (Larrea tridentata) *leaflets to nest.*

Chris George, a graduate student at U.C.L.A., is interested in the comparative ecology of desert ant communities. She is currently working with Roy Snelling of the Museum on the ecology and distribution of California desert ants for the Bureau of Land Management. She is also actively engaged in the study of honey ant ecology in the western Mojave Desert. Ms. George has taught both graduate and undergraduate courses at California State Polytechnic University, Pomona, and appeared on the ABC-TV program "Animals, Animals, Animals" in a segment dealing with ants which was aired last December and April.

The English Large Copper, Lycaena dispar dispar, *first known (1860s) butterfly extinction due to human impact: draining of the fens in lowland East Anglia brought about its decline. (Photo by Charles L. Remington)*

HOW TO CONSERVE INSECTS FOR FUN AND NECESSITY

By Robert Michael Pyle

You are an insect conservationist, at least in spirit. You don't step on spiders and you don't use Raid in the home or Black Flag in the garden. You pay your dues to the Xerces Society. You read TERRA's article on butterfly gardening and you put it into practice, attracting Gulf Fritillaries to feed and breed in your back yard. You are truly one of the enlightened few, who knows that all that matters is not bold.

Now, you visit a museum gift shop to select nature-inspired gifts for your friends or children at Christmas-time, and what do you see? Real butterflies in Riker mounts, pinned in plastic boxes and entombed on dead flowers under glass domes. How should you react—with delight, horror—or indifference?

Each of those responses might be justified, given the individual circumstances. The subject of insect conservation is a complicated one; and insect commercialism, although only a small part of the overall picture, is no more simple.

As anyone who notices anything should know, real butterfly products have become very common indeed—in museum shops, five-and-dimes, gift stores, flea markets—anywhere people spend money for home decorations and gifts. Considering the high visibility of butterfly items, increasing yearly, alongside the whole collectors' market about which the public knows next to nothing, it might seem obvious that there is cause for concern. But wait—before you run out to shout "alarm!" in the streets, there are some other things you should consider.

Whenever land is altered for some human purpose, whether for housing, commerce, industry or intensive agriculture, it is taken out of the habitat-bank for native wildlife. This means for insects, as well as for bluebirds or pumas. As an insect conservationist, you watch hundreds of acres undergoing changes in or near your own community every year. Do you relate these changes to the beneficial insect populations which inhabit those acres? Now there seems to be a quandary arising: what does the intelligent friend of insects worry about most—butterflies under glass, or caterpillars under asphalt? Who are the real villains—the dealers, or the 'dozers? To find out, we must consider the nature of the insect business, the

Natural predation of a hairstreak butterfly by a spider. Such events serve to regulate, but not to seriously reduce, insect numbers.

The habitat of the endangered El Segundo Blue (Euphilotes battoides allyni) *near the Standard Oil refinery in El Segundo, California. This has been made a reserve through the joint efforts of Standard Oil of California and the Xerces Society.(Photo by J.P.Donahue)*

extent of habitat damage, and the ways in which insects cope with the effects of each.

The main trump held by most insects is easy to guess: they are the very masters of reproduction. Having evolved elaborate visual and chemical and behavioral mechanisms to find the proper mate and to avoid the wrong one, insects may frequently be found *in copulo.* Any watcher by the pond has seen dragonflies in their strange, contorted coupling; the idler in the meadow has watched butterflies circling one another in stratospheric flights, or dancing in fluttering, stroking duets near the ground. Beetles are encountered piggy-back nearly as often as solo. The result of all these trysts is an utterly astonishing number of fertilized insect eggs—a quantity so vast that the plants of the world could withstand total insect survival for no more than a few generations before they disappeared. Clearly, insects are good at replacing themselves. They rely heavily on predation to keep their numbers within bounds.

The other side of the insect equation for success is food-plant specialization. There are some insects, such as plague grasshoppers and woolly bears, which can consume and thrive on a great variety of plants. But most butterfly larvae and other plant-eating insects specialize on one or a few hosts. This enables them to get good at eating that which others find distasteful. It permits the insect class to split up the available resources among an incredible number and array of species. Diversity and abundance are the great yardsticks of evolutionary success, and in these, insects set the standards. Their enormous achievement can be attributed to their huge reproductive potential and their ability, as a whole, to utilize virtually all kinds of terrestrial plants.

Now let's consider conservation in light of these facts. We have seen already that insects can withstand, even require, heavy predation. On the other hand, most species require certain kinds of plants—hence, certain kinds of habitats. It should begin to dawn on us that large-scale disturbance of the landscape could have profound consequences for insect diversity, wiping out the majority of specialists and allowing only a handful of generalists—often the so-called "pests"—to survive in the simplified ecosystem. This has already happened to a large degree in Hawaii. In contrast, it becomes hard to believe that humans with nets could significantly dent a population destined to lose ninety-five percent or more of its members to predators infinitely more efficient than ourselves.

Insect ecologists know that habitat alteration threatens thousands of species of insects, while trade collectors, let alone amateurs and scientists, have a negligible effect over all. Habitat, clearly, is almost the entire problem. However, having said that, we need to backtrack and say that every situation should be considered on its own merits or demerits.

Not every insect species, after all, is a super-producer. In the tropics especially, certain kinds have opted for a longer lifespan and great size rather than impressive fecundity. Logically, these could suffer potentially greater impact from intensive collecting. Combine these characteristics with a high market value, and you may have an insect capable of being diminished by commercial take. Perhaps the best examples would be certain of the giant birdwing butterflies (genus *Ornithoptera*) of New Guinea. Sometimes exceeding ten or even twelve inches in wingspan, these beautiful beasts live for many months and lay relatively few eggs—perhaps a tenth of their swallowtail relatives' broods. What is more, the birdwings' great dimensions and brilliant colors have made them especially desirable to collectors for a century. Recent transactions have seen hundreds of dollars spent for a single pair of birdwings. Real apprehension that such pressures could impair whole populations of birdwings led to international agreements on banning their import or export without permits. This is indeed the sort of situation which inspires a black market, and which conservationists would do well to

Urban development is stealing more and more habitat from butterflies each year. Chief instrument in this process is the bulldozer. (Photo by J. P. Donahue)

concern themselves with. But how does it relate to the butterfly in the museum gift shop?

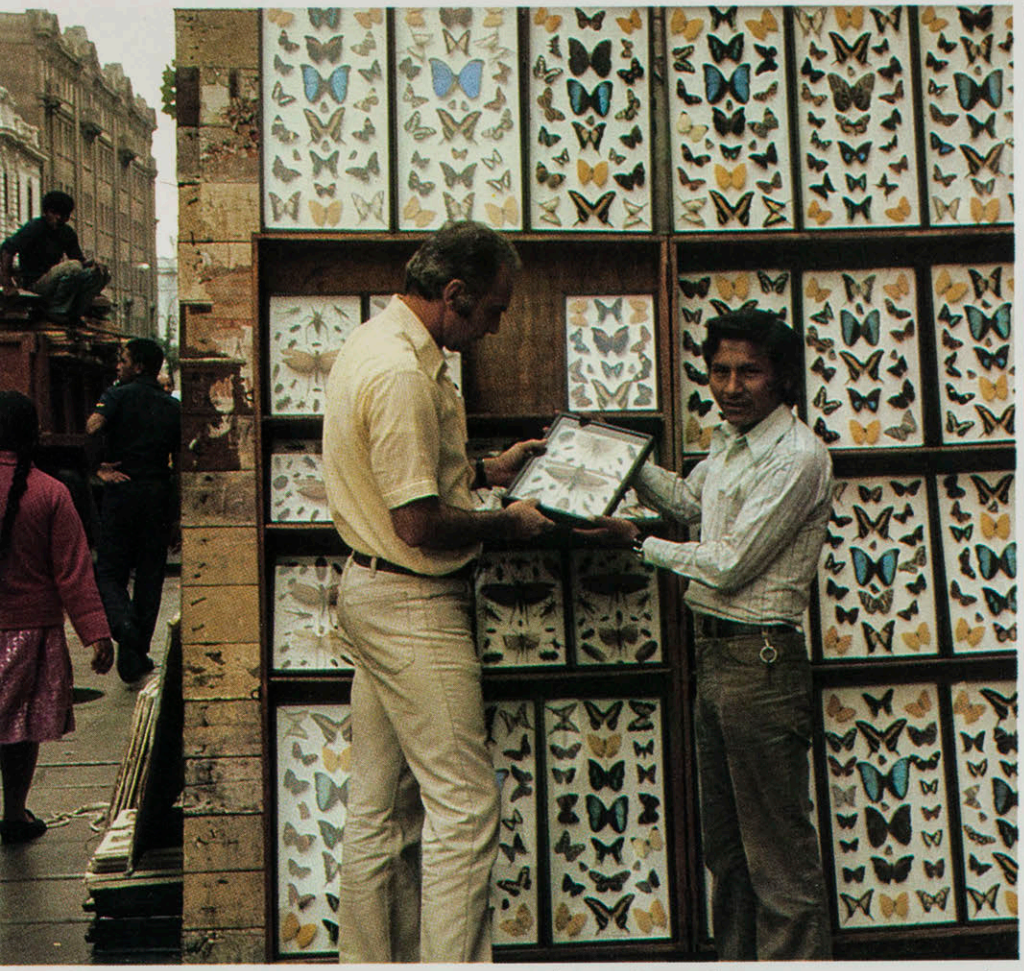
Not very closely, as it turns out. In the first place, the Government of Papua New Guinea, has determined to protect the birdwings and abolish the black market. To a large degree, they are succeeding, with fines and deportations. In the second place, there is the price factor. Certain species of rare birdwings still get out of Irian Jaya, Papua New Guinea's Indonesian neighbor on the west half of the island of New Guinea. But these items would never turn up as ornaments; they would command high sums in private dealings, legal or otherwise. No, the butterflies in the shops are not usually the rarities, except by accident. Rather they are the abundant species which can easily be netted in numbers or reared.

Looking closely, one can detect several distinct kinds of insect trade. Papua New Guinea exemplifies the high quality, high value, low volume type, like traditional Swiss products. The government-regulated trade relies heavily on perfect specimens reared for the purpose by village butterfly farmers. When other butterflies, beetles and stick insects are wild-caught for the business, conservation principles are applied by village participants. Few people actually like the idea of commercializing beautiful butterflies, but if it has to happen, and you can be sure it will in a resource-based developing country, this is the way to go. High quality specimens complete with scientific data are supplied to museums, serious butterfly students and scientists all over the world. And, since independence in 1975, laws have come into effect prohibiting expatriate profiteers or middlemen of any sort: all the proceeds go to the villagers themselves. This reform ended decades of mass exploitation of people, and reduced the impact of insect exploitation, for it gave the people a real stake in the conservation of the insect resource. The butterfly program participants, who grow hostplant vines in their own food gardens or in special farms, leave the federally protected birdwing species alone altogether.

The endangered El Segundo Blue (Euphilotes battoides allyni), *a subspecies living precariously near extinction. (Photo by Jeannine Oppewall)*

An entirely different kind of butterfly trade goes on in Taiwan. Here a vast butterfly business employs many people. The factories produce paper-bodied butterflies from the large catches of common species brought in by collectors. These have no scientific value whatsoever, and the items made from them are considered crass by many. Taiwan has yet to undertake serious butterfly farming, and most of the insects come from the wild. Here is a perfect example of a low quality, low value, high volume trade. But is it harmful? Sheldon Severinghaus, a biologist who looked into the situation, was none too sure. "About twenty million butterflies are caught each year," he reports, "but that may not necessarily impair the population of a species if it is promiscuous." The reasoning here is that nearly all the butterflies taken are males, yet males, which can mate repeatedly, are relatively expendable.

The same factor explains why conservationists are not particularly worried about the giant trade in blue *Morpho* butterflies from Brazil: virtually all those taken are males. The crucial females are left behind because of their dowdy colors. Besides, Brazil has passed a law requiring any wildlife to be exported must be raised for the purpose, and that is slowly coming into effect for the morphos. Nonetheless, insect conservationists are far from sanguine about the future of the morphos and other Latin American tropical butterflies. The reason: large-scale, rapid and constant conversion of the moist tropical forests to weedy pastures, highways and housing. Once again, habitat destruction is the real evil. And the same is true in Papua New Guinea, where we began, especially since the birdwing trade is coming under control. One of the most critically endangered butterflies in the world is also the largest butterfly in the world—Queen Alexandra's Birdwing. Occupying only a narrow strip of the Papuan coastal lowlands, *Ornithoptera alexandrae* in recent years has given up much of its habitat to logging and oil palm plantations. The latter promised to extirpate it altogether, until the new government stepped in with a genuine determination to save this and other of its magnificent insects. Steps are currently underway to establish reserves.



Pupa of the Common Green Birdwing butterfly. (Photo by S. A. Hughes)

Lima, Peru street vendors sell selections of butterflies and other spectacular insects supplied by collectors in the jungles across the Andes. (Photo by J. Robertson)

Elsewhere, conservationists are realizing similar successes among the many habitat losses. A brief armchair journey up the Pacific Coast will illustrate the breadth of the effort. Public, private and corporate entities are all taking part. Standard Oil of California owns some small dunes near Los Angeles which support one of the two remaining colonies of the El Segundo Blue butterfly, next to a refinery. The Xerces Society convinced the corporation to set aside this habitat and to manage it for the butterflies, which meant fencing from dune buggies and removing invading iceplants which compete with the larval hostplant. If successful, as it appears it will be, this action should prevent the El Segundo Blue from joining the extinct Xerces Blue (from which the Xerces Society derived its name) in oblivion. Up and off the coast, most of Santa Cruz Island—the largest of the California Channel Islands—has recently been purchased by The Nature Conservancy. This 55,000-acre preserve will provide permanent sanctuary for a host of island-endemic insects. Many of these have not even been adequately studied, but Professor Charles L. Remington of Yale and others are doing so as fast as they can. Now it appears they will be able to carry on their studies without fear of their research base vanishing from beneath their feet, as so often happens to ecologists and other field biologists.

Northward into Oregon, the U.S. Forest Service, again at the urging of the Xerces Society, has declared a certain salt-spray meadow to be "key wildlife habitat." This meadow, in the Siuslaw National Forest, is not being set aside primarily for elk, nor for bear—but for butterflies. For this is one of the last places where the Oregon Silverspot flies. Most such oceanside meadows, rare anyway in the forested Northwest, have gone for condominiums, campgrounds or golf courses; but the Oregon Silverspot and its caterpillars' violets can go nowhere else. Presently to be considered as an endangered species by the U.S. Department of the Interior, Fish and Wildlife Service, this rare fritillary can be expected to survive at least in one place.

Not the home of a single rare species but a mixed habitat with notable diversity of native butterflies, Big Soos Farm in Washington is a different kind of place. An old riverside homestead in the developing outskirts of Seattle, the farm is being given by Harold and Ann Johnston to become the Big Soos Butterfly Preserve. The Xerces Society will manage the land for maximum numbers and variety of native arthropods, for purposes of study and education. A regional Insect Interpretation Center will be established, where the Society will teach positive arthropod awareness, in the conviction that much of the success of insect conservation will always rely on people's attitudes toward insects.

One attitude to be taught at Big Soos will be the relative impact of the various degrees of butterfly population abuse. Visitors will learn that between the extremes of complete annihilation from habitat destruction and insignificant losses due to sampling by the professional researcher, there lies a continuum. Somewhere in the middle stand the ornamental trade dealers, making a profit by imbedding butterflies in an array of classy or kitsch items from expensive paperweights to clear plastic toilet seats, causing delight, distress or disgust, but probably little damage to populations. At the far end of the spectrum crouch those few commercialists who specialize in heavy exploitation of the rarest species for an elite clientele, likely having a negative impact in some cases. Then there are variations, such as the New Guinea villager who farms butterflies like pigs or papayas—they are all resources, and they all contribute to a meager economy. One would prefer to see no commercial exploitation of butterflies perhaps; but if

A Papua New Guinea butterfly farmer, Mr. Blu Rari. His chief crop is the Common Green Birdwing (Ornithoptera priamus). *(Photo by author)*

that is how you get a people to conserve the habitat, in their own interest, is it justifiable? Most tropical ecologists think so.

The facts seem to indicate that most collecting, commercial or otherwise, no matter how distasteful to onlookers, fails to depress numbers of insects in the long run. And since habitat destruction is total where collecting is seldom even significant, effective conservation becomes a matter of wise priorities. In a house fire, you don't take time to turn down the thermostat. Likewise, with limited energy and money for insect conservation, it simply doesn't make sense to concentrate on the abolition of trade, when there is a habitat holocaust going on.

So next time you spot a tacky butterfly doodad with an outrageous price-tag in the local shopping center, feel free to turn up your nose and curse the collector if you wish. But be sure to save a little ire for the shopping center's thirty-acre parking lot: Your concern just might be better placed.

Farmed female of Common Green Birdwing (Ornithoptera priamus), *to be released to replenish the wild stock. (Photo by author)*

THE XERCES SOCIETY

The Xerces Society is an international, non-profit organization dedicated to the conservation of habitat important to the survival of terrestrial arthropods. The name comes from the Xerces Blue *(Glaucopsyche xerces)*, the first butterfly to be brought to extinction in North America through human impact. A former resident of the San Francisco Peninsula, the species last flew at the Presidio, where the final colony succumbed to land development in the early 1940s.

The members believe that small, invertebrate wildlife which makes up most of the life on earth, deserves the attention of conservationists just as do whales and redwoods. Through education, research and public involvement, they hope to prevent losses elsewhere of insects and other butterflies like the Xerces Blue.

For further information regarding the Xerces Society, write Ms. Joan DeWind, Briggs Hill Road, Sherman, CT 06784.

Dr. Pyle founded The Xerces Society on 9 December 1971, during the course of his graduate studies in butterfly conservation as a Fulbright-Hays Scholar at the Monks Wood Experimental Station, England. He served as the Society's first Director while conducting his doctoral Research at Yale University, and is now the Northwest Land Steward for The Nature Conservancy in Portland, Oregon. His many publications include the book, Watching Washington Butterflies *(Seattle Audubon Society, 1974).*

COMMON HOUSE AND GARDEN SPIDERS OF THE LOS ANGELES AREA

The Green Lynx Spider is one of our most voracious insect predators. Here, a female holds a metallic sweat bee mercilessly in her jaws. (Photo by Jim Hogue)

By Mel E. Thompson

I am here, without hope, in defense of spiders. Like the captain of a sinking ship I remain on board knowing that there is little chance of my words staying afloat. Eight long, often hairy legs, piercing fangs, a venomous bite and sticky webs have been the undoing of these maligned creatures. How many have gone down under the slap of a shovel or swat of a folded newspaper as if they deserved the fate of blood-sucking and dangerous monsters? How many scratches and swollen bumps have been assigned to the innocent spider when they were caused in actuality by the mosquito's beak?

The spider is really not an enemy but a friend, a most efficient little insect trap if given a chance. It outdoes Peststrips, poison sprays and fly swatters as ridders of pests and requires little living space; a crack in the wall or cupboard corner make a home. By virtue of numbers alone, spiders devour more insects than do birds. This is one reason why everyone loves birds, so why not a motive for a little sympathy for spiders?

My purpose is now revealed, to reintroduce you to an old houseguest and visitor, not to transform you into spider lovers, but rather, at least, spider tolerators. I believe that if I can first teach you some real facts about spiders in general, dispelling some misbeliefs and revealing some fascinating secrets of their lives, and then acquaint you with the worth and beauty of some of our commonest species, you will become appreciators of spiders.

Spiders have been depicted through history as both good and evil with a majority of the older tales having a more positive theme. One worldwide motif represents the spider as a good luck omen, and to kill a spider brings bad luck. As a child I remember my mother saying that finding a spider in the closet on clothing was the harbinger of good news or a gift. Other stories from Europe and America relate that spiders found on clothing are preparing to weave new garments or repair existing holes. Some authorities believe that these stories stem from the Greek tale of the maiden Arachne and her weaving contest with the goddess Athene. Arachne was transformed into a spider by the goddess for weaving too well, and these latter adaptations refer to her bringing luck, gifts and weaving new clothes (hence the name "Arachnida" for the class which includes the spiders).

Spiders are placed in the phylum Arthropoda. Arthropoda literally means joint-footed and describes well the outward appearance of these segmented animals encased in armor. Crayfish, sowbugs, millipedes and insects are just a few other examples of the over one million species in the phylum.

Spiders can be distinguished by the number and nature of body divisions and appendages. The head and thorax are fused into one division, the cephalothorax, with a stem connecting it to a second body division, the abdomen. Immediately in front of the mouth are the chelicerae, the biting and crushing tools of the spider. Next are a pair of leg-like appendages called pedipalps or "hand-feet." Shorter than the walking legs, they function as food handlers for subadults and adult females, and are modified in males for mating purposes. Eight walking legs in four pairs follow the pedipalps. With a hand lens you may see additional

spider characteristics, eight simple eyes clustered on the anterior, dorsal surface of the cephalic area and a group of spinnerets protruding at the posterior end of the abdomen.

Silk spinning is perhaps the best known characteristic habit of spiders. Spider silk is almost all protein and is produced by glands in the abdomen. Each gland is connected to a group of tiny spools and spigots that are scattered across the spinning field of each spinneret. Snares to capture prey are the most obvious use of silk, but many spiders spin protective bags to molt, hibernate, mate or spend the night. Egg sacs and draglines (safety ropes) also are constructed of silk.

One of the more bizarre uses of silk is ballooning. This means of dispersal is employed by spiderlings and smaller adult spiders. Climbing to the highest point possible, facing the direction of the wind, raising the body high off the substrate, tipping the abdomen up and releasing silk threads are the preparations for take off. The threads are caught-up in the breeze and pulled out into the air. Spiders are known to have travelled several hundred miles in this manner. The end result of massive numbers of ballooning spiders periodically makes news when blobs of webbing fall from the sky or large areas are covered with old ballooning threads known as gossamer.

Spiders are predatory and it is vital for the male to be recognized as a mate and not a meal. In the mating process the mature male first fills his pedipalps with sperm through a process known as sperm induction and then wanders in search of a female. The sexes find each other through any one or combination of the following: 1. chance contact, 2. airborne odors, 3. scent trails laid down in silk threads by females or contact with female's snare, 4. visual recognition.

Once a male recognizes the presence of a female, courtship usually begins. Non-web-building spiders tap the ground with their pedipalps and can display their legs like a semaphore going through what many early observers called a dance.

The female, if receptive, will respond to these jerky, rapid movements with similar, less exaggerated displays. An interesting form of life insurance is employed by the European spider *Pisaura mirabilis*, for the male presents the female with an insect and mates while she is feeding.

Web building spider males touch, pull and vibrate the female's web for recognition. In the genus *Steatoda* males have stridulatory (sound producing) organs on their abdomens, while other genera possess files on their chelicerae and pins on the inside of their pedipalps. The vibrations from these organs travel through the web to the female. Contrary to popular belief, males do not necessarily become the female's next meal. If she is well fed and not in the process of developing eggs the male survives to mate again with her or another female.

Because of their predaceous and venomous nature spiders are often portrayed as sinister and dangerous. In the well-worn film "Sherlock Holmes Meets the Spider Lady," Holmes and Watson stand by while an "entomologist" identifies a harmless tarantula. Mr. Gillflower: "...the deadliest insect known to science. It is the *Lycosa carnivora*, habitat the upper reaches of the Ubongo River." Holmes: "Its bite is fatal?" Mr. Gillflower: "Hideously, human beings are its food and prey and its venom once injected into the bloodstream causes such excruciating agony that the victim is driven to self-destruction."

While a few species are capable of inflicting fatal bites to humans, the venom of most is mild and used only to kill small prey, usually insects. The venom is injected with the chelicerae which are made up of two parts, a broad base and movable, narrow, pointed fang. Poison glands either lie in the basal portion or extend into the body. A duct from these glands leads to an opening just inside the tip of the fang. After killing its prey, the spider proceeds to pour digestive juices from the coxal glands into the corpse to predigest the tissues. The resulting fluids then are sucked into the spider's mouth by the action of the muscular stomach.

The question most frequently asked is, "What will happen to me if bitten by a spider?" The answer depends on the kind of spider and a number of variables. No one ever knows how much venom will be injected. Most people do not know how sensitive they are to a particular spider's venom. Other factors include body weight, age, and general physical condition at the time of envenomation. If you are bitten by a spider, see your physician; and if at all possible, bring the remains of the spider with you for identification. Although a few are dangerous, such as the black widow, with neurotoxic venom, and the introduced violin spiders, with a cell-destroying poison, most spiders possess venom that does little harm to people. Bites from our largest local spider, the tarantula, are comparable to that of a bee sting.

In the past homes have produced tolerable living conditions for a variety of spiders. In many cases so good they have followed us all over the earth. Today modern homes with more efficient heating systems frequently create low humidity and a desert-like climate. This is tough on spiders. The few that are successful in this dry air are able to survive long periods without water. On the positive side there is an abundance of insect life to feed upon in the average home. Silverfish, cockroaches, grain beetles, flour moths, ants and termites can be found in the best of neighborhoods. The garden and surrounding landscaping of a home can also provide the necessary requirements if not too heavily sprayed with insecticides.

If you insist on removing spiders from your home, you might try the following alternative to extermination. Take an appropriate size jar or drinking glass and place over the unwanted spider. Then slip a stiff piece of paper under the jar forcing the spider onto the paper. Turn the glass over and tap the spider off the paper. You may now open the door and release the spider.

I now rest my case in defense of spiders and hope you recognize and appreciate a few of the following guests to your homes and gardens in the months ahead.

1 Tarantulas (*Aphonopelma*, family Theraphosidae)

There are several kinds of tarantulas common to the Los Angeles area. Males are frequent visitors to hillside homes from late August to November. They climb up screen doors and building walls in search of a receptive female. Reported as "deadly, loathsome creatures" by early Californians, we now know them to be harmless. Hairs on the abdomen are "kicked" off by the hind legs as a defense against mammalian predators. These tiny, barbed missiles cause discomfort when lodged in tender mucus membranes of the eyes, nose and throat.

2 California Trap-door Spider (*Bothriocyrtum californicum*, family Ctenizidae)

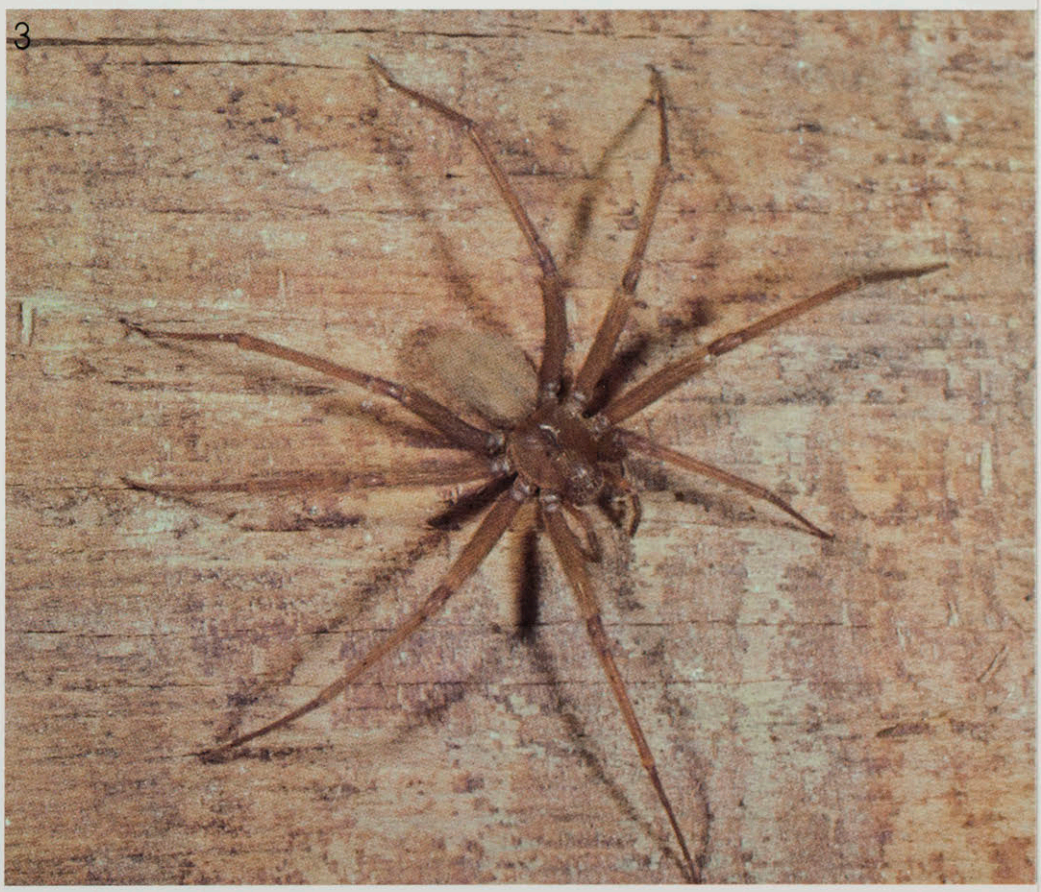
Not to be found in your house and a very unlikely inhabitant of your garden, *Bothriocyrtum* is a well-known yet inconspicuous resident of the Los Angeles area. Preferring the sides of old road cuts and slopes, they build subterranean, tubular homes complete with silk lined walls and thick, snug fitting trap-doors. They accomplish this feat with a built-in digging tool consisting of stout, large spines located along their jaws. The outside of the door may be covered with soil, moss and twigs, making their detection difficult. The spider can also stop intruders by becoming a "living lock," placing its fangs into tiny holes in the door and pulling down with an incredible force equalling 140 times its own body weight.

3 South American Violin Spider (*Loxosceles laeta*, family Loxoscelidae)

Over two hundred of these introduced spiders were found in the city of Sierra

Madre in 1968. They have only been found in buildings and probably cannot survive outside in natural surroundings. The sheet web is a very distinctive ribbon-like silk and there is usually a retreat in a crack, crevice or corner. The most distinctive feature of this yellowish brown spider is six eyes in three pairs in a strongly curved row on the anterior surface of the flattened carapace.

Several native species of *Loxosceles* occur in our local deserts that are much smaller and rather difficult to find. Adults have gone without food or water for over two years and do not appear shrivelled or impaired by the fast. Their venom causes a severe necrotic local reaction at the site of the bite and the end result may leave a deep ulceration which takes forty to fifty days to heal.



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4 Common Dysderid (*Dysdera crocata*, family Dysderidae)

You may discover this brick-red spider while raking leaves or moving stones, boards or clay pots in the garden. This is an European spider that wanders through our gardens feeding almost exclusively on sow-bugs. Its massive chelicerae are an adaptation for piercing the tough armour of these land crustaceans.

5 Long-bodied Cellar Spider (*Pholcus phalangioides*, family Pholcidae)

This globe trotting spider is often confused with a close spider-like relative, the daddy-long-legs. Males will often share a web with females for long periods, which is not typical spider behavior. Females hold the loosely-constructed egg sac in their chelicerae until hatched. When disturbed, cellar spiders whirl around and around on long, thin legs until their body becomes a blur. Several dozen whirling spiders are a magnificent sight. Everyone should have a few pholcids sharing their home.

6 Black Widow (*Latrodectus hesperus*, family Theridiidae)

The common name "Black Widow" has been given to three species of the genus *Latrodectus* that are known to be harmful to humans in the United States. Fantasy reigns with exaggerations about size and behavior in supposed or real encounters with a Black Widow. Most people think any black spider is a widow, which confuses the issue more and results in a lot of dead black spiders. There are, in fact, hundreds of black spiders belonging to families that behave quite differently from widows. Furthermore, true Black Widow spiders are not always black. Spiderlings fresh from the egg sac appear to be white or cream color. As they molt a pattern of yellow, black, cream and red becomes more apparent on their abdomens. They are normally upside down in their webs, making it easy to see the identifying red hour-glass pattern on the abdomen. Their venom is neurotoxic and can cause fatalities. Fortunately, only a minute quantity is injected by the spider resulting in fewer than one percent of those bitten dying.

7 False Widow (*Steatoda grossa*, family Theridiidae)

A very common house spider, the False Widow is often mistaken for the Black Widow. Preferring dark, damp areas this purplish-brown to black spider possesses no red hour-glass and is considered harmless. The cotton-like egg sacs can easily be distinguished from the Black Widow's tough parchment-like sacs.

8 House Spider (*Achaearanea tepidariorum*, family Theridiidae)

A small spider with a long scientific name, the House Spider is not a tidy housekeeper. The irregular web is usually strewn with leaves, twigs and old insect corpses. In some instances they may tie a few leaves together forming a retreat. Look for them around the outside of your home near the foundation.

9 Golden Garden Spider (*Argiope aurantia*, family Araneidae)

Females of this large and beautiful silver, yellow and black orb weaver construct their circular snare low to the ground in tall grass, weeds and shrubs. They build no retreat and take up a position at the hub of the web, head down. Two other related species occur locally, the Silver Garden Spider *(A. argentata)* with a lobed abdomen and predominantly silver color, and the Banded Garden Spider *(A. trifasciata)* with a cream and black-ringed abdomen. Members of this genus usually construct a stabilimentum, a wide zig-zag band of silk that runs through the center of the orb, whose exact function is unknown. Large size, bright colors and diurnal habits of these spiders have made them too conspicuous; they are needlessly destroyed by the uninformed.

10 Common Neoscona (*Neoscona oaxacensis*, family Araneidae)

Our most common summer orb weaver, this species is identifiable by two pair of ventral yellow spots on the abdomen. This successful garden spider is nocturnal in hot, dry areas and active around the clock in cool, moist habitats.

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11 Green Lynx Spider (*Peucetia viridans*, family Oxyopidae)

Our local lynx spider is a bright green hunter that crawls and jumps over vegetation in search of insect prey. Although the adults have no snare or retreat, the young have been observed constructing small horizontal webs. The egg sac is knobby and about the size of a grape; it produces myriads of bright orange spiderlings in about two weeks.

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12 Corner Spider (*Hololena curta*, family Agelenidae)

This is the curse of those who must have clean corners. Its sheet-like platform webs ending in a funnel retreat can cover every crack and corner of a home's exterior. Shrubs, patio furniture and neglected barbecues will not escape their webby attentions. In addition to the horizontal sheet a network of aerial threads are strung above to impede the flight of potential insect prey.

13 Jeweled Aranea (*Araneus gemma*, family Araneidae)

One of several species of *Araneus* in Los Angeles possessing shoulder humps on the anterior lateral surfaces of the abdomen, this nocturnal heavyweight of spiderdom can startle the most enthusiastic spider watcher if the web is accidentally encountered on a dark night. During the day they can be found close by the orb in a retreat of leaves or on the underside of a branch.

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14 Mouse Spider (*Scotophaeus blackwalli*, family Gnaphosidae)

This is a speedy ground spider with spinnerets resembling twin tail pipes. It is often seen wandering on walls, ceilings and curtains in the home. A European species that has found its way to the Pacific coast, it is reported in only one other area in North America. It has been called the "Mouse Spider" due to the silky hair-like appearance of its abdomen. It has been known to feed on freshly killed insects, destroying recently pinned entomological specimens.

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15 Cream House Spider (*Chiracanthium inclusum* or *mildei*, family Clubionidae)

These two pale yellowish green twins can only be separated under magnification. *Chiracanthium inclusum* is our native species while *C. mildei* is a recent import from Europe. They both invade buildings and when not searching for food make a thick, white, bag of silk for a retreat. They have relatively long fangs and have been known to bite humans, causing only minor local irritation.

16 Crab Spider (*Misumenoides formosipes*, family Thomisidae)

The Crab Spider ambushes as it sits undetected on the heads of flowers. A quick strike between the head and thorax from this master hunter instantaneously immobilizes insects of all kinds, from stinging wasps to giant dragonflies. *Misumenoides formosipes* and a close relative *Misumena vatia* have the ability to change color. The results of a series of experiments indicated that males and young of *Misumena vatia* cannot change color reversibly, but adult females can change from white to yellow on a yellow paper and back to white when placed on white paper.

17 Red Jumping Spider (*Phidippus johnsoni* or *kaibabensis*, family Salticidae)

These are the largest representatives of a very large group of spiders; many species, large and small and of all color combinations, live in the Los Angeles area. Our common species can be identified by their red abdomens, dark cephalothoraxes and metallic green chelicerae. Females and subadults of *P. johnsoni* have a narrow black bar on the posterior two-thirds of the abdomen. They stalk their prey, have extremely good eyesight, and will follow movements from distances of up to seven inches.

Mel Thompson is supervisor of Whittier Narrows Nature Center and Wildlife Sanctuary, operated by the Los Angeles County Department of Parks & Recreation. He has been a student of arachnology (spiders and their relatives) for many years and is currently treasurer of The American Arachnological Society.

FROM THE GOLD RUSH TO THE HOLLYWOOD RUSHES SOME NOTES ON THE HISTORY OF BUTTERFLY FARMING IN CALIFORNIA

By Jeannine Oppewall

If you were to make a list of the world's most unusual occupations, butterfly farming would have to come out somewhere near the top. A butterfly farm is a strictly commercial enterprise—raising butterflies and moths for profit, to sell to collectors, jewelry designers, or school systems. Someone growing swallowtail caterpillars on the dill in his back garden just for fun would not qualify as a butterfly farmer. And neither would a professional entomologist breeding them for study in his lab.

There have been a number of butterfly farms in California worth noting. And the people who ran them—offbeat and venturesome amateurs for the most part—have a kind of continuity of character, some of which has a lot to do with California itself. People who talk about California often find themselves borrowing from the language of alchemy. Ever since the Gold Rush, California has been a place where base but intrepid fellows could make good. Many early settlers, like medieval alchemists, struggled for years under heart-breaking conditions with recalcitrant materials. When things did not pan out, they were obliged to return to their former occupations or avocations for livelihood.

PIERRE JOSEPH MICHEL LORQUIN Pierre Lorquin is a good case in point. An improvident French businessman and lawyer with an interest in natural history, he headed for California after losing his family fortune. He arrived in San Francisco only a dozen years after Darwin had completed his voyage on the *Beagle*. The life of a naturalist-explorer was now not only attractive and romantic, but scientifically valuable as well. There was a market in Europe for the little-known flora and fauna of unexplored parts.

Lorquin found no gold in California. He kept himself alive with odd jobs, and then turned to his old pursuit—butterfly collecting. He collected all over California for about six years, and shipped back to his old family friend and physician Jean Alphonse Boisduval, who was curator of entomology at the National Museum of Natural History in Paris, nearly a hundred different species of Lepidoptera. When he died, Lorquin had had one new species of butterfly—the Lorquin's Admiral *(Limenitis lorquini)*—two beetles, one natural history club, and one entomological society—still thriving at the Natural History Museum of Los Angeles County—named after him.

Lorquin was not a butterfly farmer, but what he did was to set the pattern for much of the entomological activity that would follow in California: he was a dogged and informed amateur stubbornly insisting on doing what pleased him most.

CHARLES AND XIMENA McGLASHAN The first real California butterfly farmers were Charles and Ximena McGlashan, a father and daughter team in Truckee. Like Lorquin, they began as informed amateurs, and then went on to make solid contributions to the world of entomology. Charles Fayette McGlashan was born in Wisconsin two years before Lorquin left France for California. His mother died two years later, and in 1851 his father gathered up his family in a covered wagon and headed for California. In the course of the long journey, the young McGlashan seems to have acquired the agility that comes from a day-to-day struggle with unfamiliar problems; he grew up absolutely unembarrassed about exploiting his own enthusiasms, whether in the interest of survival or in the interest of science.

In 1872 he found himself a job as superintendent of the school system of Truckee, a rough-and-ready, hurly-burly town over a mile high in the Sierra Nevada, on the road between Sacramento and what was later to become Reno, Nevada. Only three years before McGlashan's arrival, the Central Pacific Railroad had come through, transforming Truckee from a watering hole on the great emigrant wagon trail west into a bustling terminus on the transcontinental railroad run. In the early 1870s Truckee was just the place for an ambitious young man who wanted to get ahead. In those days McGlashan taught school, studied law, collected butterflies and moths, made notes on regional lore, gave rooftop classes in astronomy, and was local correspondent for the *Sacramento Daily Record-Union*. By 1875 McGlashan had set himself up as both a lawyer and as editor of the local newspaper, the *Truckee Republican*. In 1879 he published his now famous *History of the Donner Party*, based on interviews with the survivors still living at that time. A few years later, he was elected to the California State Assembly.

In 1893 he capitalized on a local geological curiosity—the "rocking stone"—by buying the property on which it stood and then building his own museum around it. He filled the museum with his own

collections—baskets made by local Indians, the Donner Party relics he had excavated, and butterflies and moths. McGlashan had observed that the rocking stone remained clean of snow all winter, so he carefully calculated the slope of the rock, built a house next to it with a roof of the same slope, and thereby avoided shovelling snow all winter. Set on a ridge overlooking the town, the 80-window house and its architecturally matched museum tower made a strong statement about the McGlashan hopes for the community.

The entomological side of McGlashan's story begins about the same time he arrived in Truckee. While teaching at the local high school, he took his pupils on a field trip to visit an English prospector named Oldfield who owned a telescope. Oldfield also happened to be an insect collector, and from him McGlashan first learned how to collect and rear Lepidoptera. It was not long before he got to meet Henry ("Hy") Edwards, an ardent entomologist who worked the mining camp entertainment circuit as an actor. From Edwards McGlashan learned the indispensable entomological secrets, and over a period of about a dozen years he shipped Edwards many of the moths he was able to rear. McGlashan was in touch with many of the prominent American entomologists of the day. Eventually, he was able to amass a collection of over 20,000 specimens. What remains of the McGlashan collection is now in the Nevada County Courthouse, in Nevada City, California, not far from Truckee.

Probably the most exciting period of McGlashan's career as an amateur entomologist began in 1912, when he and his seventh daughter Ximena (pronounced Hee may'nah), who had always been interested in nature study, hit on the idea of a butterfly farm. In the mid 1890s a young tobacco broker and lepidopterist named Leonard W. Newman had started a successful butterfly farm in England. It is possible that McGlashan had heard about Newman's farm; but whether he had or not, the time was right for a successful American butterfly farm. For Americans, the early twentieth century was an era of irrepressible self-confidence; it was a time of belief in markets that could not be glutted. Aggressively managed, even the most seemingly hare-brained scheme—like a butterfly farm—could be made to pay off. And in terms of publicity alone, the McGlashan farm was a huge success.

The story of how the butterfly farm got off the ground is as follows. Ximena was at something of a loss as to what to do with herself that summer of 1912. She was eighteen and had just graduated from San Jose Normal School. Her training there had prepared her for a teaching career, but she longed to attend the university. Her father insisted that before he would send her, she must first know what she wanted to study.

One night she was watching her father spread his specimens; it occurred to her that it might be a good idea if she knew a bit more about butterflies so that she could teach her potential pupils about them. McGlashan casually remarked that he thought she could earn more money catching butterflies than teaching school. He had received a standing offer from Dr. William Barnes, a wealthy midwestern collector, for anything he could collect and ship, but he was far too busy with his law business to be obliging. So he turned the offer over to Ximena, who was quick to realize its possibilities. Within two weeks she had mastered the skills of collecting and rearing and had shipped Barnes about 1500 specimens, for which

Ximena McGlashan was the subject of many articles extolling her commercial and professional exploits. (Photo by author from material loaned by Ximena McGlashan.)

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A Real Butterfly Fi

The Only Girl in the World Who Earns Her Living by Raising Rare Moths and Butterflies for Scientists and Collectors

TO keep their collections of butterflies and moths up to date almost every museum of natural history in the world relies to a great extent upon the efforts of

Ximena Exhibiting Some of Her Highly-Prized Specimens.

made promptly upon the delivery of each shipment.

he paid her $75.00. At the end of the summer, she had shipped over 10,000 specimens, and was paid a flat rate of 5¢ a specimen, which averaged out at about $50.00 a week—a lot of money for that time, and certainly more than she could have made teaching school.

A Sacramento newspaperman caught on to her activities; the Hearst newspapers picked up the story, and soon hundreds of articles about her exotic and unusually profitable business appeared all over the country. She had made the Sunday supplement scene, and the headlines could not resist the obvious word plays: "Girl Who is Turning Butterflies into Gold," "A Little Westerner Who Turns Moths into Dollars." The press nicknamed her "The Butterfly Queen." Instead of transmuting base metals into gold, Ximena McGlashan got herself a reputation for metamorphosing Lepidoptera into money. Soon she was receiving hundreds of letters from people wanting to know how they could do it too. So the next fall, in September, 1913, she and her father began publishing *The Butterfly Farmer: A Monthly Magazine for Amateur Entomologists.*

The magazine contained a "comprehensive correspondence course in entomology, conducted under the auspices of the Agassiz Association," a leading national nature study group. *The Butterfly Farmer* was full of practical information. The McGlashans told their pupils what books to read for further information; printed lists of purchasers; published desiderata; reprinted helpful hints from readers; wrote short biographies of well-known entomologists; outlined the equipment needed for collecting, and told how to make it or where to buy it; explained how to care for the eggs, the larvae, the pupae, and the adults; how to paper, relax, pin, mount and preserve specimens; how to beat the bushes for larvae; how to sugar for moths, and what to do if you lived in a dry county and could not get the alcohol necessary for the sugaring formula. (National prohibition was only a few years away.) As one enthusiastic collector put it, *The Butterfly Farmer* was "something that the average collector has been in need of since the science started...talks on bugology in plain English."

The cover of each issue of *The Butterfly Farmer* featured a small oval portrait of Ximena McGlashan, "Publisher and Proprietor"—looking sweet, slightly bashful, and incredibly innocent. What she had was genuine Gibson girl beauty—her hair piled high and loose, at ease with herself, secure, protected, and cherished. Her publication had an insistent ingenuousness that was impossible to ignore. She was convinced that her formula for success would be universally applicable, and that she had discovered a new vocation especially well suited for women: "The material is in your very dooryard to bring you a livelihood. You can literally pick dollars from the bushes." Ximena lost no time, though, in pointing out that butterfly farming was not altogether without its own peculiar occupational hazards: "A feature of night collecting which most women will dread...is being out in the dark alone. Being a mountaineer, I am never a bit afraid to go anywhere that my work calls me....The newest make of the automatic revolver is a companion that banishes fear, especially as I am a pretty good shot...."

In September, 1914, Ximena enrolled as a student of entomology at the University of California at Berkeley, putting to good use the money she had made in butterfly farming. A year later, she transferred to Stanford, where she got her degree in botany and entomology. At that time, entomology departments were completely given over to economic entomology—the study of pests and how to kill them. Few professionals were studying butterflies, so she had a tough time organizing a good program of study for her needs. Often, she

Ximena McGlashan, with boxes full of specimens ready for shipment (c. 1912). (Photo courtesy of Ximena McGlashan.)

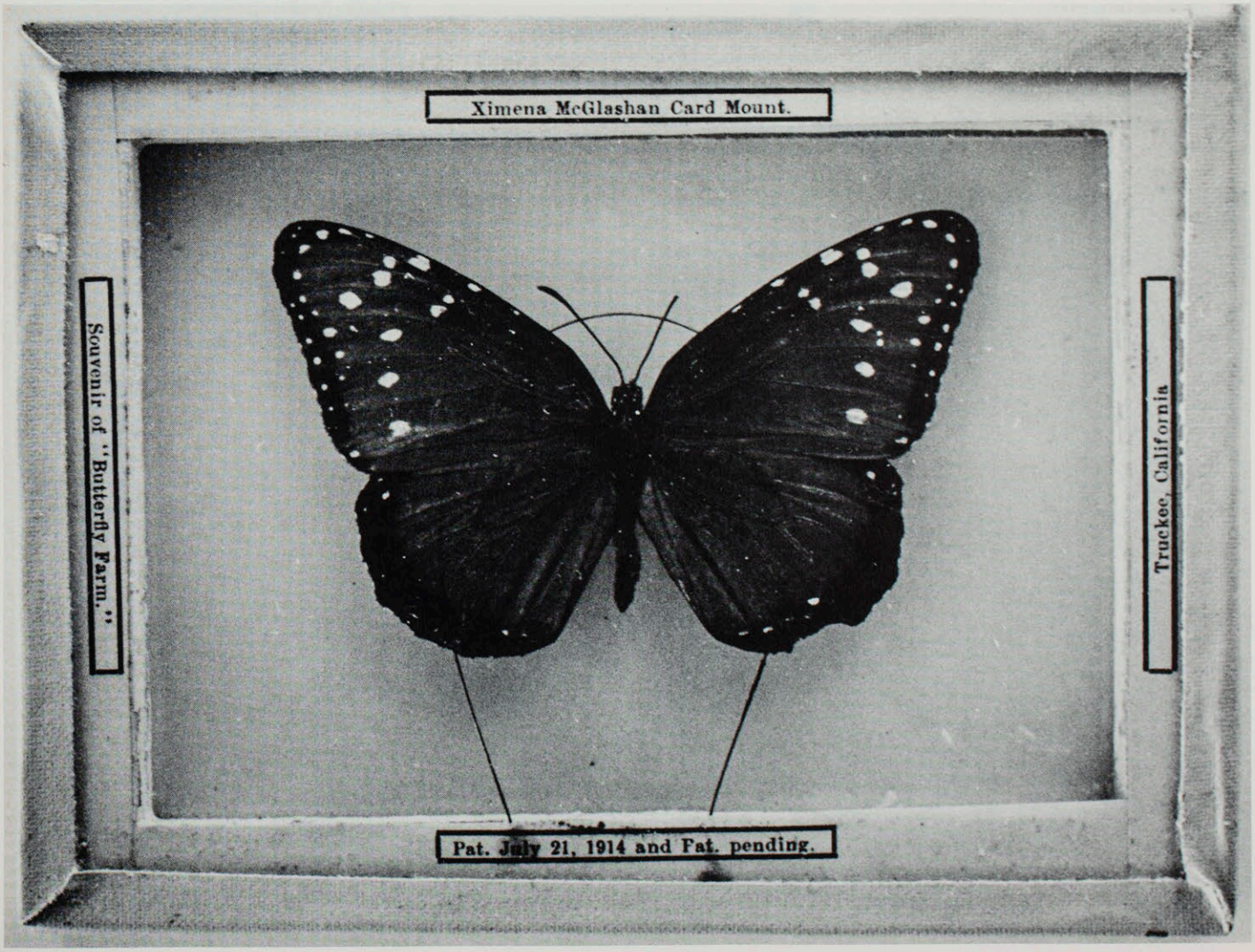
found herself the only woman in her classes; and because of her peculiar fame, her peers tended to regard her as something of a freak. Some pretty freakish opportunities were offered to her. In addition to the forty-odd marriage proposals she received, she was asked to participate in several advertising ventures. Though the details are vague, she was once asked to appear on stage with a balloon full of butterflies to be released at an appropriate moment. Another time, Gene Stratton Porter, author of *Girl of the Limberlost*, asked her to try out for a part in the Hollywood version of the book. In many ways, Ximena had looked to Mrs. Porter as a role model; the respect was evidently mutual, for Mrs. Porter once described Ximena as "a little hustler on a scientific basis." So it must have been a disappointment for both of them when Ximena refused the part. She had balked at a scene in which she was to be sprayed with the scent of female underwing moths and then photographed with hundreds of male moths clinging to her.

After graduating, Ximena was hoping to carry forward her butterfly research, but World War I—and then marriage—intervened permanently. She married John Howard, who was eventually to become a professor of military science at Berkeley, but when they were first married he was teaching survival tactics to enlisted men at Fort Leavenworth. An army wife was not supposed to work, and she was forced to carry on her interests in secret. And in a while, she discovered that two children were a lot harder to raise than a thousand caterpillars. Ximena took the idea of a family quite seriously, and never went back to farming butterflies. Today, in her mid-eighties, she lives quietly in Berkeley near her children and grandchildren. Recently she joined the Xerces Society, an organization dedicated to preserving the habitats of rare insects, so she has not forgotten the work she was doing some 60 years ago.

ALBERT AND AMY CARTER The McGlashans had an advantage that the next serious California butterfly farmers—Albert and Amy Carter—did not have: the advantage of being there first, in a newly opened, still raw territory whose unstudied indigenous inhabitants could still create a stir in eastern scientific circles. The McGlashans were able to ride the early twentieth century nature study club tide extremely well. But the First World War killed the nature study movement. And the Depression, as the Carters would discover, was not healthy for butterfly collecting either.

The Carters began their farm as a get-rich-quick scheme, and later tried marketing the idea as a kind of Depression survival kit: "Raise butterflies in your spare time at home. You can start in this business on almost no capital..."—the same vague, cheerfully phrased, chain-letter style promises of profit that had lured people to California for over a century.

They called their farm Butterfly Park. The first issue of their magazine, *Butterfly Park Nature Club News*, commenced in March, 1929, and appeared monthly through October, when the stock market crashed, and then it became



Card mount invented by Ximena McGlashan.

bimonthly for the next year. It came out quarterly in 1931, and seems finally to have petered out in early 1932, still trying to make a go of it: "The world-wide financial depression has hit all dealers in butterflies, insects and entomological supplies very hard....We are glad to tell you, however, that Butterfly Park is holding its own and growing better all the time.....This depression will not last forever, and we suggest that you collect and store away in sealed boxes, all of the perfect specimens you can get—you will need them later on."

Butterfly Park Nature Club News contained essentially the same kind of information as Ximena McGlashan's *Butterfly Farmer*—"how to succeed in the butterfly business." Probably the best information the magazine provided was a handy glossary of the adjectives most frequently used in describing butterflies—hyaline, maculated, areolate, tesselated, aureous, cyaneous, fulvous, fuscous, ochraceous, etc. Membership in the club cost $5.00 a year, but if an interested person could not afford the cash, he or she could pay in butterflies—cabbage butterflies would not be counted. The club managed to attract about five or six hundred subscribers.

The Carters would work the butterflies up into trays, mirrors, book ends, and jewelry which they would sell at the Butterfly Park, located in Roscoe, now called the Shadow Hills section of Sunland, in the northern end of the San Fernando Valley in Southern California. The park was open to nature study classes by special appointment and to the public every Sunday, free of charge. Seventy-five to one hundred visitors who would show up on Sundays could wander freely in the hundred-foot-square, specially landscaped, board-fenced, screened-in hillside insect zoo, where, as the Carters said, "16,000 caterpillars are feeding on food plants planted especially for them." The transplanted foodplants were all labelled. And there were waterfalls, picnic tables, and peacocks which sometimes flew through the screen. The park's headquarters were in a rustic log cabin which the guests would have to enter to get inside the insectarium.

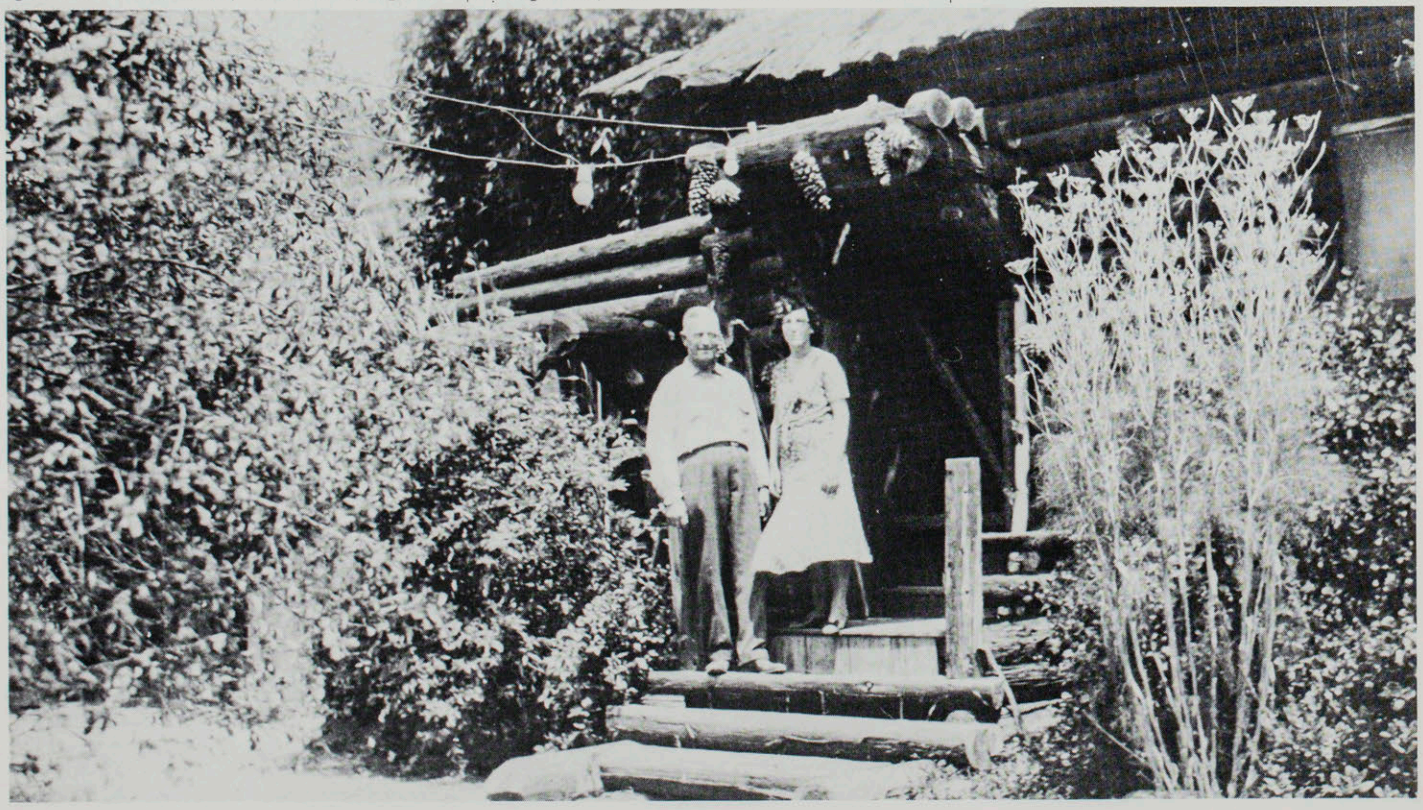
The six or seven acres on which the farm stood were actually rented; the Carters were never able to pay for it. Eventually, their marriage disintegrated, and the bugs ate most of their collection, according to Lloyd Martin, former curator of Lepidoptera at the Natural History Museum of Los Angeles County. Martin had worked for the Carters for five years, from 1930 to 1935, when the park was closed down.

CARLOS WHITE Ximena McGlashan had described her butterfly farm as a simple extension of her own native habitat, spreading out in ever-widening concentric circles from her parents' house, to her yard, and into the surrounding mountain sides. The Carters had screened in a hillside, transplanted foodplants, and made their farm into a tourist attraction. And today there is a new butterfly farm in central California that takes the next logical step: the farm has moved indoors, and the food—once gathered, then transplanted—is now manufactured.

Perhaps one of the reasons why entomology has been big in California is that the really big business of the state is agriculture. Where there are crops, there are pests. And where there are pests, there will you also find entomologists. California's central valley is probably the world's biggest vegetable patch. Here the people are still very much in tune with the growing season; the big community festival in Shafter, California, is the mid-May potato festival.

Here, surviving symbiotically alongside the Kleen-Seed Delinting Company, Red-Top Farm Chemicals, and Western Exterminators, is a small company called Insect Lore Products—a kind of indoor insectary owned by a free lance pest control consultant named Carlos White. Actually, what White owns is the world's only store-front butterfly farm, located right next door to a converted movie theatre church in downtown Shafter, about fifteen miles northwest of Bakersfield.

White is the only professional entomologist in this collection of California butterfly farmers; he got his masters degree in entomology from Illinois Univer-



Albert and Amy Carter at the doorway of their butterfly park headquarters in Sunland (c. 1930). (Photo courtesy of Lloyd Martin.)

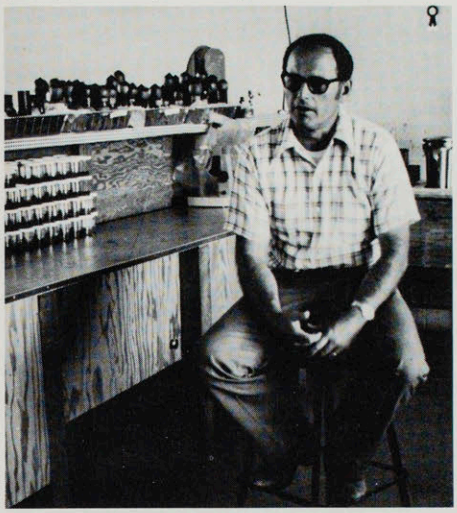
sity in 1960. But in spirit he is descended from Lorquin, the McGlashans, and the Carters: he found a way to make his private pleasures pay off. A number of years ago White persuaded a local bank to support a local idiosyncrasy, and he borrowed about $20,000 for what the *Los Angeles Times* called a "fly-by-day-operation." He and a former partner had come up with a successful synthetic diet for two species of butterflies—the Painted Lady (*Cynthia cardui*) and the Buckeye (*Junonia coenia*). When it is poured into the bottom of a plastic container, the nutrient looks like congealed pea soup. It consists of about thirty different ingredients, among them wheat germ, dried milk, preservatives, and agar—a substance which behaves like gelatin.

White maintains as his breeding stock four cages of Buckeyes and four cages of Painted Ladies—each with about two hundred butterflies. In each breeding cage White places a sprig or two of the right foodplant. The female butterflies will lay their eggs on these sprigs, and at the end of a day, White collects the sprigs, and soaks them for about twenty minutes in a mild solution of chlorine bleach. This process frees the eggs from the leaves, and kills any miscellaneous bacteria that might be present. After the tiny larvae have hatched, they are transferred to the plastic containers, where they begin to eat the synthetic food. And after a bit, they are mailed out as part of one of White's Butterfly Garden Kits.

White began by thinking of department store sales for his Butterfly Garden Kits, but quickly realized that his biggest market would be school districts. Several districts have already developed science curricula around the kits, and White ships out about three to four hundred kits a week. The kit is particularly attractive to teachers; it is a no-fuss, self-contained system, with a fast feedback loop. A complete cycle, from egg to adult, takes only about 21 days. White provides both student and teacher guides with the kits, and outlines experiments that can be done with the insects—such as observing the effects of temperature on their development and determining the location of a butterfly's "taste buds." Each kit costs about $7.00, and consists of a pink and orange, day-glo colored, plastic-windowed, easy-to-assemble coop for the mature insects, and a jar of nutrient with caterpillars who pupate cooperatively in due course on the filter paper under the lid of their containers.

White says that the most exotic experience he has had as a butterfly farmer was being asked to release hundreds of butterflies at a Hollywood premiere of the film "Butterflies Are Free." He was terribly nervous that the creatures would not cooperate, since it was night. But things went well: the butterflies, it turned out, were attracted to the blondes in the audience whose hair caught the bright lights. Since the butterflies White released that night were Painted Ladies, it just goes to show—it takes one to know one.

Carlos White seated in the laboratory of Insect Lore Products, Shafter, California. (1976) (Photo by author.)



The Carter Butterfly Farm. (Photo courtesy of Lloyd Martin.)

Jeannine Oppewall is a free-lance writer and set designer, and has been a butterfly collector for 27 years. She is an active member of The Lepidopterists' Society and, as a member of the Xerces Society, has been instrumental in preserving the habitat of the El Segundo Blue Butterfly (see related article by Robert M. Pyle in this issue).

THE BUGFOLK

By Charles L. Hogue

Man sees himself in diverse things. It seems to be an incontrovertible part of his nature to impart human characteristics to objects, even inanimate ones (Man in the Moon), but most of all to animals. This habit is called anthropomorphism and may be a modern manifestation of the animism of our ancestors, belief in the presence of a divine spirit in all things (Latin: *anima* soul).

The great number and variety of fantasized human-animal creatures that run through history attest to the profundity of those beliefs. The classic poets generated herds of heraldic monsters, combined of man and beast, like the Centaur (half man, half horse). Mythologies and folklore from all cultures harbor hosts of "half-way people," as are the Mermaids, Satyrs and Fauns. Ill-informed zoologists of the Middle Ages sprinkled their bestiaries with mixed-up beings supposed to occur in exotic lands, where we find the Lamia, a scaly quadruped with hoofs behind and paws in front, with a woman's face and breasts and male genitalia.

Among this class of mongrel "manimals" a minority race exists. These are the humanized crickets, ladybird beetles, and even spiders, a collective community of anthropoid arthropods which I like to call the "bugfolk."

The bugfolk are few probably because it is difficult for our minds to acknowledge kinship with insects; their forms are too alien to stretch easily into a human mode. It is this difficulty in hybridizing that also accounts for the different kinds and individuals we find of their category. Some are mostly bug, with only a voice or dress to humanize them ("mensects"); others are just little people with wings, antennae, or perhaps only a partly jointed body to entomologize them ("entomen"). I would exclude from their ranks shape-shifting demons who may assume an insect form temporarily as well as those oddly metamorphosed unfortunates who went insect from strange causes, like Kafka's Gregor Samsa in *The Metamorphosis* and Professor André Delambre in *The Fly*, by George Langelaan. Likewise, I refuse to recognize as bugfolk all the extraterrestrial insect monsters of science fiction; they are true aliens without an earthly conscience.

From both structural and historical standpoints, certain types of fairies may be considered among the bugfolk. I refer to the diminutive Elizabethan pucks and sylphs who possess very human bodies but fly about on lepidopteran wings. In this characteristic they are of special significance in the evolutionary history of the more modern bugfolk. There is even reason to believe that the progenitor of all was Psyche, Goddess of Greek Mythology who represented the soul and borrowed her wings from the butterfly, that insect which symbolized resurrection after death.

Jiminy Cricket. From a scene in Disney's "Pinocchio." (Reproduced by permission, © Walt Disney Productions.)

An elf attendant with butterfly wings, as imagined and depicted by Arthur Rackham (1908) from Shakespeare's A Midsummer-Night's Dream.

Bugfolk also participated in Aesop's fables more than two millennia ago: "A silly gnat settled on the horn of a bull. 'Pardon me, if my weight is burdensome, say so and I'll be off,' the gnat said. The bull replied, 'To tell you the truth, I didn't even know you were there.' " Moral: The smaller the mind the greater the conceit.

It appears, then, that primitive bugfolk have existed since antiquity, from whence we know them primarily by the descriptions of ancient authors. They appear in a few early surreal paintings, but our clearest images of them appear first about the time printing and lithography made it possible for the artist's imagination to flow freely onto paper.

Possibly the earliest of the illustrators of bugfolk was Martin Disteli (1802–1844) who illuminated many animal fables written by authors of the day. He had a fondness for grasshoppers which he civilized in a way that sets the style for the commonest species of anthropomorphized insects. These forms are insect in anatomy but are virtual humans by reason of their dress, speech, actions and intelligence.

Disteli's depictions established the prototype for a series of contemporary

The "Four Seasons," traditional roundel performed by appropriately dressed bug dancers. (From the title page of Episodes of Insect Life *by Acheta Domestica—pseudonym for L. Budgen—1851.)*

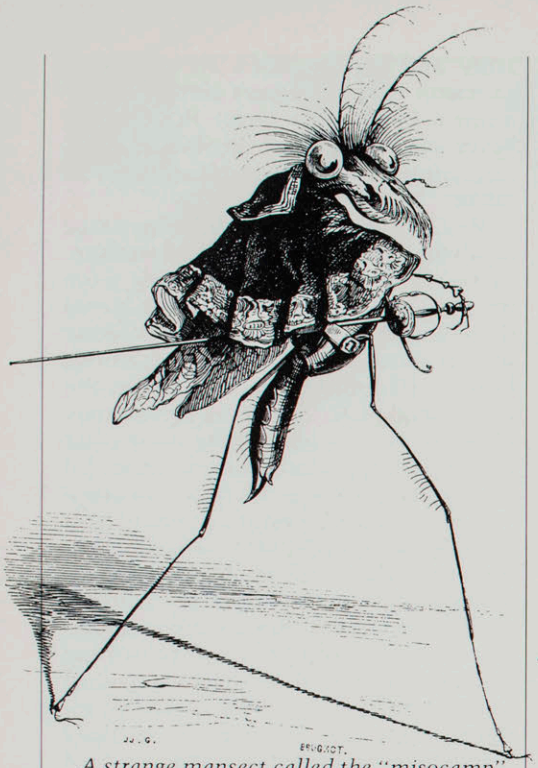
and latterday illustrators, chief of whom is Jean Ignace Isidore Gérard, better known as Grandville. Following the tradition of the animal caricaturists of his time, Grandville used familiar mammals and birds in his newspaper cartoons and book figures, but he seems to have preferred the strange shapes of moths, ants and beetles. Ultimately, he populated the bugfolk world with a whole generation of beetle warriors, grasshopper acrobats, centipede musicians and just plain bugfolk types. We see the descendants of these in the work of many book illustrators, among them John Tenniel (Lewis Carroll's *Alice* books), and Alan Aldridge, for a very recent edition of *The Butterfly Ball and the Grasshopper's Feast.*

As with all peoples, certain individuals attain a special status by virtue of forceful personalities. Probably the most famous bug person is Jiminy Cricket. Jiminy was reincarnated from the original "Talking Cricket" for the Walt Disney animated film version of the classic children's tale, *Pinocchio.* He played a central role in the story and became such an expansive character that he appears almost totally human. But do not forget that he can never shed his cricket attributes: small size, jointed body, and, above all, musical talent.

Mr. Cricket could be described as a true gentleman-bug, with humor and wisdom. (It would be interesting to know from which of his two organismal components these personality traits stem!) His funny side is natural and widespread among bugfolk, like those ant wiseacres in the comic strip "B.C." However, Jiminy may have learned his philosophy from older members of his clan, several of whom led distinguished lives as teachers or savants.

In this category we find a poet of considerable accomplishment, whose logic, unfortunately, is not enough heeded today. His name is Archy and he is mostly cockroach, but his human side is apparent from his writing and reasoning abilities. The few renderings we have of him also show him to have decidedly anthropoid features and a fondness for a derby hat (and he seems to have gained the capacity to perspire and lost a pair of legs in his metamorphosis toward humanity). Forty years ago he realized the

The marriage of the fickle butterfly and the damselfly; the lady flew off later to the big city and was burned up in a gas jet. (An illustration by Grandville, Les Animaux, *1866.)*



A strange mansect called the "misocamp" who plays a part in a chapter of Les Animaux, *(1866) by Grandville.*

A waspish wallflower by Grandville. (From Les Animaux, *1866.)*

dangers of overkill to the balance of nature and threatened an insect rebellion if humans did not stop massacring his kind.

"i shall organize the insects
i shall drill them
i shall lead them
i shall fling a billion
times a billion billion
risen insects in an army
at the throats
of all you humans" *

Bugfolk are appearing today in every conceivable literary and art form. They are especially popular with writers of children's books because of their teaching and entertaining abilities. They are called upon to frighten in science fiction stories. They fascinate us in the fabrications of the fantasists. And always they help us to see ourselves and even some great truths. In *The Monnitation* by Kenneth Smith (Phantasmagoria Five), Sgratizankel, a bug Knight errant, learned how to live with the hurt of knowing that our ideals often are beyond us. The spider sage whom he meets on his Odyssey says of ideals,

"We need their tension drawing upon our will (as indeed a spider would know). We have the ideals that we *need*—if insects of all creatures need grandeur, then so be it: As they love being insects, so must they love also the little ironies God has written into their lives. For all delusions are rooted in need: even to have the honesty to admit this requires that one have ideals to live up to."

Next time you see an insect at your feet, stoop down and take a closer look. It may be carrying a book.

The Dude of the beehive—poor drone. An insect character from Tenants of an Old Farm *by Henry McCook, 1885.*

*From "the lives and times of archy and mehitabel" by don marquis.

Dr. Charles L. Hogue considers himself a "general practioner" of entomology, although he restricts his primary field of special study to the biosystemics of primitive flies living in torrential streams. Dr. Hogue is a prolific writer for national magazines and has written field guides (Insects of the Los Angeles Basin; Insects of California) *and is compiling an introductory volume on the insects of the New World Tropics. He is head Curator of Entomology at the Natural History Museum of Los Angeles County.*

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Museum privileges and pleasures include:

Free admission for your immediate family (to age 18) at both the Natural History Museum and the George C. Page Museum of La Brea Discoveries.

Subscription to TERRA Magazine, the Museum Members' Quarterly, one of America's most colorful and informative nature magazines, a national award winner.

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Invitations to preview receptions for new exhibitions, and to the special behind-the-scenes annual open house.

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